THURSDAY, OCTOBER 18, 1888.

APPLICATIONS OF DYNAMICS TO PHYSICS AND CHEMISTRY.

Applications of Dynamics to Physics and Chemistry. By J. J. Thomson, M.A., F.R.S., Cavendish Professor of Experimental Physics, Cambridge. (London: Macmillan and Co., 1888.)

THIS is one of the most original books on mathematical physics which has appeared for a long time. Prof. J. J. Thomson has elaborated a method of very wide scope, and has applied it to a large number of problems of very different kinds. A reader of the work must perforce be struck not only with the mathematical ability of the author, but with the wide extent of learning which enables him to illustrate his theme by recent researches in nearly every branch of physics and physical chemistry.

The method employed is so essentially mathematical that it is not easy to describe it without the use of symbols. As, however, it is a matter of considerable importance that those who are studying by means of experiment the phenomena discussed by Prof. Thomson should have some idea as to the progress already made in their theoretical explanation, it may be well to give an account of the general principles which he has used.

In ordinary dynamics it is necessary to specify the positions of the members of a system of bodies of which the movements or mutual actions are under consideration. This is done by means of co-ordinates, which define their positions at a given time with respect to certain given lines or surfaces. If the system is in motion, the values of these quantities change with the time, and thus the co-ordinates may be regarded as possessing velocities.

The difference between the kinetic and potential energies of the system (which is called the Lagrangian function) can be expressed in terms of the co-ordinates and their velocities, and if this is done the magnitude of the force which is acting on the system and tending to increase the value of any particular co-ordinate can be deduced from it. If no such force is acting, it follows that a certain relation between the co-ordinates and their velocities must be satisfied.

This is a perfectly general dynamical method, which could be directly applied to the complex system of atoms and ether by which the physical phenomena displayed by any given body are produced, if it were not for difficulties which Prof. Thomson has attempted, as far as may be, to overcome.

In the first place, the dynamical method presupposes a knowledge of the relative positions of the members of the system, *i.e.* of its geometry, and we cannot at present express "such things as the distributions of electricity and magnetism, for example," in terms of the relative positions or movements of atoms and ether.

In the next place, even when we can express certain physical states in terms of quantities which completely describe all that we can observe, it is certain that in general they would not suffice to describe completely the state of the body if we had the power of noting every detail of its molecular structure.

Using theorems due to Thomson and Tait and to Larmor respectively, Prof. J. J. Thomson shows that the second difficulty may be overcome if the co-ordinates of the values of which we are ignorant do not enter into the expressions for the kinetic energy of the system. It then, however, becomes necessary to modify the Lagrangian function, but this new form is such that when it is expressed in terms of any variable quantities and their "velocities" they satisfy the mathematical condition to which a true geometrical co-ordinate and its velocity are subject. If L′ is the modified Lagrangian function, and q any one of a series of quantities, $q_1, q_2, \ldots$, in terms of which and of their velocities it can be expressed, then—

$$\frac{d}{dt} \cdot \frac{dL'}{d\dot{q}} - \frac{dL'}{dq} = 0.$$

The term co-ordinate is thus used by Prof. Thomson in the generalized sense of any quantity in terms of which and of its velocity the modified Lagrangian function can be expressed, and he assumes that as far as the phenomena under consideration are concerned the state of a body may be described by four different types of co-ordinates. These specify (1) the position in space of any bodies of finite size which may be in the system; (2) the strains in the system; (3) its electrical, and (4) its magnetic state.

The most general expression for the Lagrangian function is then formed. It may contain terms of various kinds. Prof. Thomson goes through them one by one, determines what the physical consequences of the existence of each would be, and if these are found to be contrary to experience concludes that the term in question does not exist.

Thus, for instance, it can be shown that if there were a term containing a product of the velocities of a geometrical and an electrical co-ordinate, an electrical "current would produce a mechanical force proportional to its square, so that the force would not be reversed if the direction of the current was reversed." As this and other similar deductions are all opposed to experience, no such term can exist.

A similar method is applied to the coefficients of the terms which are shown to be possible. Thus a term exists which contains the squares of the velocities of the geometrical co-ordinates. It corresponds to the expression for the ordinary kinetic energy. Prof. Thomson inquires whether the kinetic energy depends only on the geometrical co-ordinates, or whether it also varies with the electrical state of the various members of the system. The answer is given by means of an investigation of his own (*Phil. Mag.*, April 1881), in which he has shown that the kinetic energy of a small sphere, of mass m, and radius a, charged with e units of electricity, and moving with a velocity v, is—

$$\left\{\frac{1}{2} m + \frac{2}{15} \frac{\mu e^2}{a}\right\} v^2,$$

where μ is the magnetic permeability of the dielectric surrounding it. The effect of the electrification is therefore the same as if the mass had received an increment, which, however, numerical calculation shows is too small to be observed. It is, nevertheless, important that the mutual relationship between ordinary kinetic energy and

electrification should be recognized, as it follows that the speed with which electrical oscillations are propagated across any medium will be diminished by the presence of conductors moving about in it. "Thus, if the electromagnetic theory of light is true, the result we have been discussing has an important bearing on the effect of the molecules of matter on the rate of propagation of light."

It would take too long to follow the author in detail through the interesting discussion which is pursued on these lines. Another example must therefore suffice. The specific inductive capacity of a dielectric depends upon the strain, and it follows that the distribution of stress which Maxwell supposes to exist in the electric field is supplemented by another, which is due to the relation between inductive capacity and strain. Maxwell's distribution will be the same for all dielectrics, but Quincke has shown that though most dielectrics expand when placed in an electric field, the fatty oils contract. In these cases the effects of what may be called the supplementary distribution are contrary to, and greater than, those produced by Maxwell's stress.

Phenomena which depend on temperature are specially discussed, and an interesting conclusion with respect to thermo-electricity may be noted. It is that from the heat developed by a current at a junction of two dissimilar metals we can derive information as to that part only of the electromotive force which depends upon the temperature. Hence the Peltier effect can throw no light upon the absolute difference of potential between two different metals.

A chapter is devoted to the calculation of "the Lagrangian function in the simplest case, when the body is in a steady state, when it is free from all strain except that inseparable from the body at the temperature we are considering, and when it is neither electrified nor magnetized." Two forms are found, which hold for the gaseous and the liquid or solid states respectively. The general principle is also laid down, that, "when the physical environment of a system is slightly changed, and the consequent change in the mean Lagrangian function increases as any physical process goes on, then this process will have to go on further in the changed system before equilibrium is reached than in the unchanged one, while if the change in the mean Lagrangian function diminishes as the process goes on it will not have to proceed so far."

As an example of this we may take the effect of a charge of electricity on the vapour-pressure of a liquid. If a spherical drop, of radius a, surrounded by a medium of specific inductive capacity K, is charged with e units of electricity, its potential energy is increased by $e^2/2Ka$, and thus electrification changes the mean Lagrangian function by the amount $-e^2/2Ka$. Prof. Thomson quotes experiments by Blake to prove that when an electrified liquid evaporates the vapour is not electrified, so that the charge e is unaffected by evaporation, while the radius a of course diminishes. On the whole, then, evaporation algebraically diminishes the term $-e^2/2Ka$, and therefore it will not proceed so far as before the liquid was electrified. Thus electrification diminishes the vapour-tension by an amount which is limited by the insulating power of the air. The maximum effect is about equal in magnitude, though opposite in sign, to that due to a curvature of a quarter of a centimetre. The suggestion is made that we should therefore expect an electrified drop of rain to be larger than an unelectrified one, so that this effect may help to produce the large drops of rain which fall in thunderstorms. The principle also leads to the conclusion that the density of saturated aqueous vapour in the presence of air is greater than if no other gas is present, and thus, apart from other causes, rain-drops would form more easily when the barometer is falling than when it is rising.

The properties of dilute solutions are discussed at length, and the Lagrangian function is calculated in accordance with the views of Van 't Hoff on the assumption that the molecules of a salt in a dilute solution behave as though they were in the gaseous state.

The results obtained cannot be considered favourable to the view that the effects of solution are capable of being stated in such simple terms. Röntgen and Schneider's experiments on the compressibility of saline solutions prove that the decrease in the compressibility is sometimes more than a hundred times greater than that calculated on the above assumptions. The author also points out that the rise in the osmometer, which is explained as due to the pressure of the dissolved salt, may be capable of other interpretations, and that at present the indications of the instrument must be considered ambiguous.

Enough has perhaps been said to give an idea of the method and scope of Prof. J. J. Thomson's work.

It is possible that some of the experimental results which are quoted require fuller confirmation than they have as yet received, but if the work is regarded as a text-book of mathematical physics this is a very minor defect. The author has developed a method of wide scope, and it is important that its applications should be fully illustrated, even if the data assumed are not in all cases unexceptionable.

The book literally bristles with novel suggestions and points of interest. An explanation of the fact recently discovered by Mr. Shelford Bidwell, that iron becomes shorter when the magnetizing force is very great; the effect of surface-tension on electromotive force; chemical action in thin films; the effect of a neutral gas on dissociation—these are some of the subjects, in addition to those which have already been mentioned, upon which we light on turning over the pages haphazard.

That it will make the study of physics and chemistry easier is only in one sense true. *Nihil tetigit quod non ornavit* may, as applied to Prof. J. J. Thomson, be freely translated, that he hardly mentions any law of physics except to complicate it with correction terms.

From a more serious point of view, however, it is difficult to over-estimate the value of the establishment of the less obvious connections between phenomena.

On many points, such as Quincke's and Bidwell's observations on the changes of magnitude produced in the electric and magnetic fields respectively, experiment needed the support of theory, and Prof. J. J. Thomson points out causes to which the observed effects may be due. Almost daily, conscientious experimentalists are spending time and ability in the detailed examination of facts which they cannot explain, and which they can only hope to explain by the most minute investigations. In the

cases just mentioned the labour was well spent, but in others it is practically thrown away in the attempt to pierce a labyrinth the clue to which can be found only by mathematics. Prof. J. J. Thomson's book ought to be carefully studied by all physicists, and especially investigators who have discovered what they believe to be a new fact. In many cases it will suggest possible explanations which may prevent long and wearisome groping in the dark.

The author is to be warmly congratulated on his work, which is an achievement of a high order, and which will add to his already great reputation as a mathematical physicist.

RECENT WORKS ON ORNITHOLOGY.

Argentine Ornithology. By P. L. Sclater, M.A., F.R.S., &c., and W. H. Hudson, C.M.Z.S. Vol. I., pp. i.-xvi., 1-208, pls. i.-x. (London: R. H. Porter, 1888.)

British Birds: Key List. By Lieut.-Colonel L. Howard Irby. Pp. 1-58. (London: R. H. Porter, 1888.)

Birdsnesting and Bird-skinning: A Complete Description of the Nests and Eggs of Birds which breed in Britain. By Edward Newman. Second Edition. Revised and re-written, with directions for their collection and preservation; and a chapter on Bird-skinning, &c. By Miller Christy. Pp. i.-xii., 1-138. (London: T. Fisher Unwin, 1888.)

DR. SCLATER AND MR. HUDSON have combined their forces to produce one of the best books ever written on South American ornithology. Each is a master of his own portion of the subject, for no one is better acquainted with neotropical ornithology than Dr. Sclater, and Mr. Hudson has been known for many years as one of the best living observers of the habits of birds in the field. The scheme of the book, therefore, leaves nothing to be desired, and the whole of the "get-up," as regards paper, print, and illustrations (the latter a matter of course when Mr. Keulemans is the artist), is about as good as it is possible to be, and reflects the greatest credit on the publisher.

One of the most interesting features of the work will doubtless be the introduction, which will appear in the second volume, when it will be possible to form some accurate notion of the relations of the avifauna of the Argentine Republic with that of the neighbouring States, a comparison which will doubtless be of importance to all naturalists who are interested in the somewhat complicated natural areas of the neotropical region. At present the genera and species peculiar to the region treated of by the authors seem to be few in number, and they would appear to be limited to the more western portions of the country, especially the district of Tucuman.

It would be easy to give many extracts from Mr. Hudson's charming writings on the habits of the birds, with the life-history of many of which he is as familiar as we are in England with that of many of our British birds, while his travels have enabled him in many instances to give an account of species both in their summer and winter homes. To any naturalist visiting Argentina this book will be of the highest value, the descriptions given by Dr. Sclater being short and concise, but sufficient for the identification of species, while he is to be congratulated also on the success with which he has contrived to attach an English name to each bird. Everyone who has tried to do this, when writing on exotic birds, knows how difficult it is to invent English titles for species which have no counterpart in European nomenclature; and we must acknowledge that the names are a great improvement on some of the zoology "as she is taught" at our Zoological Gardens. Should some of the names bestowed upon animals in the "Zoo" ever be adopted in general works of travel, we might expect to find such truthful anecdotes as the following:—

"The insolent behaviour of one of the animals considerably annoyed us, from its persistent habit of making 'long noses' at us. On shooting a specimen we discovered that it was a Rude Fox (*Canis rudis*)," &c., &c.

"Some interesting little creatures now came in sight, dancing, apparently in perfect time, across the glade. They proved to be Pleasant Antelopes (*Tragelaphus gratus*)," &c., &c.

"Just as I was emerging from a thicket I managed to trip over something which brought me heavily to the ground. I fancied that I had fallen over a tree-stump, but on careful examination, it proved to be an Inconvenient Curassow (*Crax incommoda*) which had somehow got in my way," &c., &c.

In his useful little work, a "Key List to British Birds," Colonel Irby has supplied a real want—a handy pocket-book, giving just the diagnostic characters of every species. It is a desirable supplement to the "List of British Birds" published by the British Ornithologists' Union, which dealt with the nomenclature of the various species, but which might also with advantage have contained diagnoses, such as Colonel Irby's industry has now supplied.

What Colonel Irby has done for the birds, Mr. Miller Christy does for the eggs of British birds, and it is certain that with this little work in his hands the young student can gain a very good idea of the eggs which are likely to be met with in England. The call for this second edition of the late Mr. Newman's work shows apparently that there are a good many egg-collectors in this country, notwithstanding the prohibitions of an Act of Parliament; nor can we state with truth that there is any falling off in the number of students of the egg-collection in the British Museum since the Wild Birds Preservation Act became law. To the chapter on bird-skinning we would add a practical hint that before commencing operations a tiny wisp of wool should be inserted into the palate of the specimen. This greatly prevents the risk of discharge from the nostrils, and saves many a skin from being draggled and spoilt. The American method of enveloping the prepared skin in wadding is also far preferable to our method of fastening a paper band round the specimen.

R. BOWDLER SHARPE.

OUR BOOK SHELF.

Mechanics. By Edward Aveling, D.Sc. (London: Chapman and Hall, Limited, 1888).

THIS is the first of four treatises on mechanics and experimental science, published to meet the requirements of candidates in the matriculation examination of London University. The volume before us contains a great number of numerical examples and exercises for students, and twenty pages are devoted to specimen examination

papers of various kinds. The author's language is very inexact if compared with the language of Thomson and Tait's "Natural Philosophy," or Dr. Lodge's text-book. It reads as if a shorthand-writer had taken notes of lectures, and the lecturer had published them after hasty correction. This inexactness is visible in almost every definition in the book. We read of velocities acting and accelerations working. New magnitudes are introduced; thus, "the intensity of a force is like the temperature of a body. It is measured by the velocity communicated, apart altogether from the mass to which it is communicated." "But the quantity of a force is like the amount of heat in a body. Force-quantity is measured by the product of the velocity communicated *and* the mass to which it is communicated" (p. 103). In defining, if he can be said to define, "impressed force," the author uses expressions such as "so that when we speak or read of an accelerating force, f or g, or 9·8 or 32·2, or a per second per second."

This book would certainly not be recommended by us to any student who is desirous of obtaining a knowledge of mechanics; but, for all we know, it may very well serve the purpose for which its author has designed it. It is a book written for candidates in certain examinations by a successful candidate. The author has introduced side lines to catch a student's eye, and we think this a very clever contrivance. Thus there is the side line "Pressure" (p. 2), and the student is directed to get off by memory: "When a body is prevented from falling towards the earth by the hand or by a table, *e.g.*, the body exerts a certain pressure upon the hand or the table." It is interesting to know from such an authority as Dr. Aveling that this is the sort of definition which satisfies an examiner, and it seems to us that a study of this book by examiners would lead to very useful results.

Solutions of the Examples in an Elementary Treatise on Conic Sections. By Charles Smith, M.A. (London: Macmillan, 1888.)

MR. SMITH has been well advised in drawing up this collection of elegant solutions to the examples in his "Conics." His treatise is just now in the full tide of success, and seems likely to maintain its position for some time yet before a better one drives it into the background. This, then, is just the time when such aid as is here furnished is most acceptable to teachers, "many of whom," as we have more than once stated in these columns, and as the author here testifies, "can ill afford time to write out detailed solutions of the questions which prove too difficult for their pupils." We have compared many of the solutions here given with our own (in manuscript), and find that new light is thrown on some by Mr. Smith's thorough command of the latest methods. We have detected here and there a trifling error, which may perhaps cause momentary trouble to a self-taught student, but there is sufficient detail given to enable the reader, on careful perusal, to make the required correction. In some cases more than one solution is given: this is a good feature. The possessor of the text-book and of the "Solutions" occupies a strong position, and should be able to attain considerable skill in this particular branch of mathematics.

The Beginner's Guide to Photography. By a Fellow of the Chemical Society. (London: Perken, Son, and Rayment, 1888.

THIS is a second edition, revised and enlarged, of an elementary guide for those commencing the art of photography. In it will be found practical hints as regards the choice of apparatus, and a good explanation of the whole process of photographic manipulation, written in a manner which for beginners leaves nothing to be desired.

An article on "Exposure" has been added by Mr. H. S. Platts, including tables and directions, and the latter, if carried out by the amateur, ought to give him good results.

There are, also, chapters on the production of lantern-slides, enlarging, and photomicrography, and the book concludes with a collection of the illustrations referred to in it.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Prophetic Germs.

IN his letter of October 8, the Duke of Argyll says that he sees great value in my statement (which he improperly terms an "admission"), that natural selection cannot act upon any structure which is not already developed up to the stage of actual use. He says, "This is really all I want for my previous argument, because all organs whatever do actually pass through rudimentary stages in which actual use is impossible." Here we have the Duke's case in a nutshell. It is easily dealt with. Firstly, what the Duke terms an "admission" on my part is an essential and explicitly stated element of Mr. Darwin's own exposition of his theory. Secondly, it is necessary for the Duke to demonstrate not that "all organs whatever," but that *some* organs "do actually pass through rudimentary stages in which actual use is impossible."

The stages here alluded to are—if I understand correctly—ancestral stages, not stages in the embryological development of the individual.

I feel bound to state that I do not know of any facts in the history of either animals or plants which lead me (or, I may say, which have led any important number of the vast army of writers and observers on these subjects) to the conclusion that any existing active organ has passed through rudimentary stages in which actual use is impossible, if we set aside such cases as may be explained by correlation of growth or by the persistence of vestiges of formerly useful structures.

If the Duke of Argyll can show that any one organ has or "must have" passed through such useless stages (not explicable as due to correlation of growth nor as inherited vestiges), he ought at once to do so. Mr. Darwin, in his severe testing of his own theory, tried to find such cases, and did not find them. What are they? My own opinion is that they do not exist, and that the Duke's case collapses.

E. RAY LANKESTER.

A New Australian Mammal.

A FEW days ago, through the kindness of Mr. A. Molineux, of Adelaide, a small mole-like animal, which appears to be new to science, was forwarded to the South Australian Museum. It was found on the Idracowie cattle-station, at a distance, I understand, of about 100 miles from the Charlotte Waters Telegraph Station, on the overland line from Adelaide to Port Darwin; but the exact circumstances of its capture are not yet to hand. The collector, however, reports that it must be of rare occurrence, as, on questioning the aboriginals of the locality, there was only one old woman who said she had seen it before, and that upon a single occasion.

It is evidently an underground burrowing animal resembling somewhat the Cape mole (Chrysochloris) in its general external appearance, but differing in many respects.

The total length is 13 cm., inclusive of the tail, which is 2 cm. long. The head, relatively shorter than Chrysochloris, has a rounded muzzle, the dorsal surface of which is covered by a horny shield. Nostrils transversely slit-like. No eyes visible, the skin passing uninterruptedly over the ocular region; but on reflecting the skin on one side of the face a small circular pigment spot is visible in the position of the eye. No apparent bony orbit. Tongue fleshy, broad at the base, and tapering to a blunt point. No external ears; but the ear-openings distinct, 1 mm. wide, and covered over with fur.

The fore-limbs are short, resembling somewhat those of a mole; but the manus is folded, so that the large nails of the fourth and fifth digits only are visible in the natural position of

the limbs. Of these nails the fourth is 15 mm. long and of a uniform width of 4 mm., ending very bluntly; the fifth is very slightly shorter than the fourth, broad at the base (8 mm.), tapering rapidly to a blunt point, the two together forming an outline rather like that of a goose-mussel (Lepas). The nails of the third, second, and first digits, very much smaller, form a series gradually diminishing in size in the order named, and constitute a second row on the inside of the fourth and fifth, by which, as stated, they are completely concealed from view. What corresponds to the palm is the cleft between the two rows of digits.

The hind-limbs are also short, with the soles turned outwards. What appears to be the fifth (anterior) digit is very short, with a short, broad, and strong nail; the fourth is armed with a long (7 mm.) narrow, curved, and sharp claw, while the claws of the third, second, and first are broad, flat, rounded at their points, and joined together by a membrane which extends nearly to their points. On the sole there is a hard, elongated, horny tubercle crossing it transversely.

The tail, 2 cm. long, and 5 mm. wide at the insertion, tapers to 3mm., and terminates in a knob-like tip.

About 15 mm. in front of the vent (? cloaca) there is a pouch in the integument about 4 mm. wide, with the opening directed backwards and having a depth in a forward direction of from 4–5 mm. The surface of this pouch is devoid of hair, but the bare area is surrounded by thick fawn-coloured fur, with a slightly reddish tint; it is possible, however, that this reddish tint is due wholly or in part to some ferruginous-looking sand which is much mixed up with the fur. The body generally, with the exception of the lower two-thirds of the tail, which is bare, is covered with fur of a rather lighter tint.

With regard to the internal parts, it is unfortunate that the specimen came to us completely eviscerated, and in a bad state of preservation generally; but in a small part of the lower bowel which was left, remains of ants were found. The bowel terminates at a wide vent (? cloaca), and I can find no trace of a separate genital aperture, nor of such openings into the supposed cloaca.

I have not yet had time to examine with minuteness the skeleton, which unfortunately is also considerably damaged, especially about the occipital region; but from a cursory examination of the recently-skinned body, I can note the following points, with, I believe, accuracy:—

Cranium relatively large; no bony orbits; zygomatic arches present; well-developed shoulder-girdles with slender clavicles; pectoral muscles large; pelvis large and strong, with a rather wide symphysis pubis, but no epipubic bones, either actual or rudimentary; ribs, 14; angle of lower jaw markedly inflected.

The teeth are peculiar, and require a more extended description than I can give at present, but the formula appears to be—

$$i\,\frac{3}{3},\ c\,\frac{1}{1},\ m\,\frac{6}{5}\left(?\ \frac{p\ 2,\ m\ 4}{p\ 1,\ m\ 4}\right).$$

This, however, may require some modification, as just posterior and external to the premolar (or first molar) of the right ramus of the mandible there is a small rudimentary conical tooth, which is not to be found on the opposite side, nor at corresponding positions in the maxilla.

I do not pretend to be a zoological expert, but I cannot help being struck with the resemblance both of the lower jaw and of the general characters of the teeth to the pictures of the jaws of Amphitherium as figured in various osteological works. I am now endeavouring to obtain other specimens, and meanwhile am having careful drawings made of the various parts of the present example of what appears to be a remarkably curious and interesting animal even in this land of strange and antique types.

E. C. STIRLING.

The University, Adelaide, South Australia, August 29.

Nomenclature of Determinants.

NATURE of October 4 opens with a review of a book on "Determinants" by two pupils of Prof. Valentin Balbin, whose energy and enthusiasm have done so much for mathematics in the University of Buenos Ayres. In regard to the naming of the various special forms of determinants, your reviewer says:—"The nomenclature adopted in the second book differs in some particulars from that employed by Muir. Thus, our authors do not follow him in substituting 'adjugate' for the more euphonious and more familiar adjective 'reciprocal,' and they agree with Scott and others in calling those determinants 'orthosymmetrical' which Muir names 'persymmetric.' We think that their name 'determinante *hemisimétrica*' is a distinct improvement on the old '*zero-axial skew* determinant,' but . . ."

Now, as I have gone on a definite principle in the selection of the technical terms used in my book, and as I believe that this principle is one which receives very general approval among students of science, I shall be glad if you will allow me to direct attention to it. It is that, unless very strong reasons to the contrary can be adduced, the first name given to a scientific object or concept should not be departed from.[1] In more aphoristic form, the multiplication of synonyms is a great evil. Judged by this principle, the terms "adjugate," "persymmetric," and "skew" deserve the place I have given them. "Adjugate," as applied to a determinant, was a generation old before "reciprocal" was proposed; and—what is no mean additional recommendation—it carries with it the sanction of the highly-honoured names of Gauss and Cauchy. To outweigh these claims there is very little to be said for the rival word. It is not more appropriate; indeed, the kind of connection to be indicated does not involve the idea of reciprocity at all. It is true, as your reviewer says, that "reciprocal" is a more familiar word; but the use of a familiar word in a new and therefore unfamiliar sense is surely not to be commended. In regard to "persymmetric," similar language may be employed. It was proposed by Sylvester, and was in use for years by him and others before "orthosymmetric" made its appearance. The latter is not an etymological mongrel, but it is also not one whit more appropriate than the word it seeks to supplant, and it is the unfortunate parent of the monster "doppelt-orthosymmetrisch." It never was heard in England until 1880, and I regret that my friend Mr. Scott should have seen cause to introduce it. As for the third word, "skew," the arguments in its favour are still stronger. The determinant in question was called "skew" in English and "gauche" in French, by Cayley, as far back as 1846; and these words, and their German and Italian equivalents, are to be found employed in scores of original memoirs by the highest mathematicians. "Hemisymmetric" is but of yesterday, and, so far as I know, has never been used by any mathematician of note.

Is it merely a proof of the decadence of our insularity to find a welcome given by Englishmen to terms of foreign coinage which have been wantonly proposed to displace the original words of Cayley and Sylvester? and what does it prove to find Germans, who at first derided the tropical luxuriance of Sylvester's nomenclature, now out-Heroding Herod without having Sylvester's exculpating accompaniment of tropical luxuriance of *ideas?*

Your reviewer's protest against Dostor's introduction of "multiple determinants" I cordially support, and only wish that he had taken space to show the numerous absurdities connected therewith.

THOMAS MUIR.

Beechcroft, Bothwell, N.B.

A Shadow and a Halo.

"E. W. P." may see the phenomenon he describes any sunshiny morning or bright moonlight night, when the dew is heavy on the grass. The halo being caused by reflection at a small angle of the sun or moonlight from the wet surfaces of the blades of grass, enhanced by contrast with the dark shadow (and having nothing to do with moist air), its brightness would no doubt be increased by the foreshortening and consequent apparent compression of the reflecting surfaces on the slope. The neighbourhood of a high hedge would diminish it by lessening radiation, and the consequent cooling of the grass and deposition of dew upon it.

NATURE naturally takes no account of moral analogies, of which Nature herself is full. Else one might note that a man never sees a halo round his own head unless he turns his back to the light.

B. W. S.

Hampstead Heath, October 6.

OFTEN and often in walking or riding over the chalk downs of Wiltshire or Hertfordshire I have observed a bright halo surrounding the shadow of my head. This is usually cast by sun

[1] The introduction of "continuant" may seem to do violence to this inciple; but the letter referred to by your reviewer will show the opposite.

or moon in bright clear weather, and extends with a radius of about three times the shadow's diameter around the head alone. It is probably due to diffraction of light-waves, an explanation of which at length may be read in Glazebrook's "Optics" and in other text-books. But your correspondent omits the most extraordinary character of the phenomenon. It is a curious fact that any man can see the light around the shadow of his own head, but *never* about the shadow of another. Few people notice this halo, but when once pointed out to them, they tell me they frequently observe it. It is particularly clear when thrown across a valley from one ridge to another on the opposite side. I have puzzled over this spectral brightness for five years, and never found an explanation of the fact that no one can see anyone's halo but his own. I have delayed writing to NATURE until cause and effect could both be given, but they are not forthcoming.

Another curious appearance is a rainbow thrown by sunlight on black sound ice, probably due to polarization by crystals. On the one occasion when I saw it on a pond, I had no time to observe details. Has anyone seen the like? A. S. EVE.

Marlborough College.

Nesting Habit of the House Sparrow.

I SHOULD be glad to know if any of your correspondents have noticed a nesting habit of the house sparrow (*Passer domesticus*) which I have very frequently observed in this part of New Zealand. In many of the deep cuttings in our roads and in the cliffs upon our river-banks, where the formation is a light pumiceous sand, these birds are in the habit of burrowing holes similar to those of the sand-martin (*Hirundo riparia*). In some cases I have found these burrows by measurement to be as much as 6 feet in depth.

Can this be a recently acquired habit, and will it not have an influence upon the anatomical development of the bird? G. L. GRANT.

Waihou, Auckland, N.Z., September 5.

Sonorous Sands.

I NOTICE a letter from my friend Mr. A. R. Hunt in your issue of last week, and add a line to say that the sand which our common friend, the late Admiral Bedford, gave him was, *probably*, of my collecting.

I found that the sand in Studland Bay is sonorous, during a visit to Swanage, in 1869, and was, for many years, in such constant communication with the late Admiral Bedford, exchanging notes and specimens, that I think I must have given him the sonorous sand in question, though I cannot remember the circumstance.

Anyway, there is no doubt that the dry sands of Studland Bay are powerfully sonorous. Walking with my son and a young friend of his across the bay in July 1869, we all amused ourselves by kicking the musical dust before us, the two younger pairs of heels getting quite a volume of sound out of the performance. D. PIDGEON.

Holmwood, Putney Hill, October 6.

A Shell Collector's Difficulty.

IF Mr. Layard will discard "tightly-corked tubes" altogether, and keep his minute shells in open-ended sections of glass tube, lightly closed, at top and bottom, with cotton-wool, he will have no more trouble from "milky efflorescence," which will not form in presence of the "thorough draft" he will thus establish in his cabinet. D. PIDGEON.

Holmwood, Putney Hill, October 13.

Yorkshire Geological and Polytechnic Society.

IN accordance with a request made by the Council of the Yorkshire Geological and Polytechnic Society, I am compiling a history of the past fifty years' work of the Society, and including in it biographical notices of some of its principal members. Amongst the latter was the Rev. W. Thorp, who for several years held the office of Honorary Secretary, and took great interest in the Society. He was at one time vicar of Wemersley, and afterwards removed to Misson. Unfortunately I can obtain no records of his life. Can any of your readers assist me? Any information will be gratefully received and duly acknowledged. I believe Mr. Thorp died about 1857. JAMES W. DAVIS.

Chevinedge, Halifax, October 15.

MODERN VIEWS OF ELECTRICITY.[1]

PART IV.—RADIATION.

XI.

WE have next to consider what happens when electrical waves encounter an obstacle.

Mechanism of Electric Radiation.

In forming a mental image of an electrical wave, we have to note that three distinct directions are involved. There is (1) the direction of propagation—the line of advance of the waves; (2) the direction of the electric displacements, at right angles to this; and (3) the direction of the magnetic axis, at right angles to each of the other two.

One may get a rough mechanical idea of the process of electrical radiation (at any rate in a plane) by means of the cog-wheel system already used in Part III. Imagine a series of elastic wheels, in one plane, all geared together, and let one of them be made to twist to and fro on its axis; from it, as centre, the disturbance will spread out in all directions, each wheel being made to oscillate similarly and to transmit its oscillation to the next. Looking at what is happening at a distance from the source, we shall see the pulses travelling from left to right; the electrical displacement, such as it is, being up and down; and the oscillating axes of the wheels being to and fro, or at right angles to the plane containing the wheels. The electric displacement is small, because the positive and negative wheels gearing into one another move almost equally, and accordingly there is the merest temporary balance of one above the other, due to the elastic "give" of the wheels. The magnetic oscillations, on the other hand, are all in one sense, the positive wheels rotating one way and the negative the other: all act together, and so the magnetic oscillation is a more conspicuous fact than the electric oscillation. Hence it is often spoken of as electro-magnetic radiation rather than as electric radiation. But the energy of the electrostatic strain is just as great as that of the electro-magnetic motion; in fact the energy alternates from the potential to the kinetic form, or *vice versâ*, at every quarter swing, just like every other case of vibration.

Prof. Fitzgerald, of Dublin, has devised a model of the ether, which by help of a little artificiality represents the two kinds of displacement—the electric and magnetic—very simply and clearly.

His wheels are separated from one another by a certain space, and are geared together by elastic bands. They thus turn all in one direction, and no mention need be made of positive and negative electricity as separate entities.

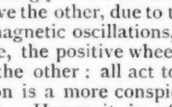


FIG. 48.—Fitzgerald's Ether Model. A set of brass wheels connected by common elastic bands. If the bands are taken off any region, it becomes a perfect conductor, into which disturbances cannot penetrate.

But, the wheels being massive, a rotatory disturbance given to one takes time to spread through the series, at a pace depending on the elasticity of the bands and the inertia of the wheels; and during the period of acceleration one side of every elastic is stretched, while the other side is relaxed and therefore thickened. This thickening of the elastics goes on in one direction, and corresponds to an electric displacement in that direction; the direction being perpendicular both to the direction of advance of the disturbance and to the axes of the wheels. A row of wheels corresponds to a section of a wave-front; the

[1] Continued from p. 419.

displacements of india-rubber and the rotating axes, *i.e.* the electric and the magnetic disturbances, both lie in the wave-front.

Clerk Maxwell's originally suggested representation was not unlike this.[1] It consisted of a series of massive wheels, connected together not by a series of elastic bands but by a row of elastic particles or "idle wheels." These particles represented electricity; their displacement during the period of acceleration corresponding to the one-sided thickening of the elastic bands in Fitzgerald's model.

I have proposed to contemplate a double series of wheels geared directly into one another, and representing positive and negative electricity respectively, because it seems to me that so many facts point to the existence of these two entities, and because then no distinction has to be drawn between one part of the medium which is ether, and another part which is electricity, but the whole is ether and the whole is also electricity; while, nevertheless, a much-needed distinction can be drawn between a motion of the ether as a whole, and a relative motion of its component parts—a distinction between forces able to move ether, *i.e.* to displace the centre of gravity of some finite portion of it, and forces which shear it and make its components slide past each other in opposite senses: these latter forces being truly electromotive.

If it be asked how the elasticity of the ether is to be explained, we must turn to the vortex sponge theory, suggested by Mr. Hicks[2] (principal of Firth College, Sheffield), and recently elaborated by Sir William Thomson.[3] But this is too complicated a matter to be suited for popular exposition just at present. It must suffice to indicate that the points here left unexplained are not necessarily at the present time unexplainable, but that the explanations have not yet been so completely worked out that an easy grasp can be obtained of them by simple mechanical illustrations and conceptions. At the same time, the general way in which motion is able to simulate the effects of elasticity will be found popularly illustrated in Sir William Thomson's article "Elasticity" in the "Encyclopædia Britannica"; and the fact that elastic rigidity of a solid can be produced by impressing motion on a homogeneous and otherwise structureless fluid must be regarded as one of the most striking among his many vital discoveries.

We have seen that to generate radiation an electrical oscillation is necessary and sufficient, and we have attended mainly to one kind of electric oscillation, viz. that which occurs in a condenser circuit when the distribution of its electricity is suddenly altered—as, for instance, by a discharge. But the condenser circuit need not be thrown into an obviously Leyden-jar form; one may have a charged cylinder with a static charge accumulated mainly at one end, and then suddenly released. The recoil of the charge is a true current, though a weak one; a certain amount of inertia is associated with it, and accordingly oscillations will go on, the charge surging from end to end of the cylinder like the water in a tilted bath suddenly levelled.

In a spherical or any other conductor, the like electric oscillations may go on; and the theory of these oscillations has been treated with great mathematical power both by Mr. Niven and by Prof. Lamb.[4]

Essentially, however, the phenomenon is not distinct from a Leyden jar or condenser circuit, for the ends of the cylinder have a certain capacity, and the cylinder has a certain self-induction; the difficulty of the problem may be said to consist in finding the values of these things for the given case. The period of an oscillation may still be written $2\pi\sqrt{(LS)}$; only, since L and S are both very small, the "frequency" of vibration is likely to be excessive. And when we come to the oscillation of an atomic charge the frequency may easily surpass the rate of vibration which can affect the eye. The damping out of such vibrations, if left to themselves, will be also a very rapid process, because the initial energy is but small.

But whether the charge oscillates in a stationary conductor, or whether a charged body vibrates as a whole, it equally constitutes an alternating current, and can equally well be treated as a source of radiation. Now, when we were considering the subject of electrolysis we were led to think of molecules as composed of two atoms or groups of atoms, each charged with equal quantities of opposite kinds of electricity. Under the influence of heat the components of the molecules are set in vibration like the prongs of a tuning-fork, the rate of vibration depending on and being characteristic of the constants of the particular molecule. The atoms being charged, however, their mechanical oscillation is necessarily accompanied by an electric oscillation, and so an electric radiation is excited and propagated outwards. These vibrations would appear to be often of the frequency suited to our retina, hence these vibrating atoms indirectly constitute our usual source of light. The "frequency" of the visible radiation can be examined and determined by optical means (some form of interference experiment, usually a diffraction grating), and hence many of the rates of vibration possible to the atoms of a given molecule under given circumstances become known, and this is the foundation of the science of spectroscopy.

It is possible that the long duration of some kinds of phosphorescence may be due to the atoms receiving indirectly some of the ethereal disturbance, and so prolonging it by their inertia, instead of leaving it to the far less inertia of the ether alone. It is possible also that the definite emissivity of some fluorescent substances is due to periods of vibration proper to their atoms, which, being disturbed in an indirect way by receipt of radiation, re-emit the same radiation in a modified, and, as it were, laden manner.

To get some further idea concerning the way in which an oscillating charge or an oscillating charged body can propagate radiation, refer back to Fig. 39, Part III. (NATURE, vol. xxxvii. p. 346), and imagine the rack oscillating to and fro. It will produce rotatory oscillation in the wheels gearing into it, these again in the next, and so on. If the wheel-work were rigid, the propagation would go on at infinite speed to the most distant wheels, but if it be elastic then the pace of propagation depends on the elasticity and the density in a way we have already said enough about. The line of rack is the direction of electric oscillation, the axes of the wheels the direction of magnetic or rotatory oscillation, and at right angles to both these is the direction of advance of the waves. True, the diagram is not a space representation, it is a mere section, and a very crude suggestion of a mechanical analogy to what may be taking place.

The wheels being perfectly geared together and into the rack represent an insulator or dielectric: there is no slip or frictional dissipation of energy—in other words, there are no true electric currents. The electric oscillation is a mere displacement oscillation due to elasticity and temporary give of the elastic wheels, whereby during each era of acceleration they are thrown slightly into the state represented in Fig. 46 (vol. xxxvii. p. 367) as contrasted with Fig. 37 (*ibid.* p. 345).

Effects of encountering a New Medium.

Now contemplate an advancing system of waves, and picture their encounter with an obstacle; say, a medium of greater density, or less elasticity, or both. If the new medium is a perfect insulator, it must be considered as

[1] *Phil Mag.*, April 1861.
[2] Brit. Assoc. Report, 1885. Aberdeen, p. 930.
[3] B.A. Report, 1887, Manchester, p. 486. Also *Phil. Mag.*, October 1887.
[4] Phil. Trans., 1881 and 1883. Also by Prof. J. J. Thomson, Math. Soc. Proc., April 1884.

having its wheels thoroughly geared up both with themselves and with those of the initial medium, so that there is no slip or dissipation of energy at the surface. In this case none of the radiation will be lost: some will be reflected and some transmitted according to ordinary and well-known mechanical laws. The part transmitted will suddenly begin to travel at a slower pace, and hence if the incidence were oblique would pursue a somewhat different path. Also, at the edges of the obstacle, or at the boundary of any artificially limited portion of the wave, there will be certain effects due to spreading out and encroaching on parts of the medium not lying in the direct path. These refraction and diffraction effects are common to all possible kinds of wave propagation, and there is nothing specially necessary to be said concerning electrical radiation on these heads which is not to be found in any work on the corresponding parts of optics.

Concerning the amount and direction of the reflected vibrations there is something to be said however, and that something very important; but it is no easy subject to tackle, and I fear must be left, so far as I am concerned, as a distinct, but perhaps subsequently-to-be filled-up, gap.

If the gearing between the new medium and the old is imperfect, if, for instance, there were a layer of slippery wheels between them, representing a more or less conducting film, then some of the radiation would be dissipated at the surface, not all would be reflected and transmitted, and the film would get to a certain extent heated. By such a film the precise laws of reflection might be profoundly modified, as they would be also if the transition from one medium to another were gradual instead of abrupt. But all these things must remain for the present part of the unfilled gap.

Electric Radiation encountering a Conductor.

We will proceed now to the case of a *conducting* obstacle—that is, of waves encountering a medium whose electrical parts are connected, not by elasticity, but by friction. It is plain here that not only at the outer layer of such a medium, but at every subsequent layer, a certain amount of slip will occur during every era of acceleration, and hence that in penetrating a sufficient thickness of a medium endowed with any metallic conductivity the whole of the incident radiation must be either reflected or destroyed: none can be transmitted.

Refer back to Fig. 43 (vol. xxxvii. p. 347), and think of the rack in that figure as oscillating. Through the cog-wheels the disturbance spreads without loss, but at the outer layer of the conducting region A B C D a finite slip occurs, and a less amount of radiation penetrates to the next layer, E F G H, and so on. Some thickness or other, therefore, of a conducting substance must necessarily be impervious to electric radiation: that is, it must be opaque.

Conductivity is not the sole cause of opacity. It would not do to say that all opaque bodies must be conductors. But conductivity is a very efficient cause of opacity, and it is true to say that all conductors of electricity are necessarily opaque to light; understanding, of course, that the particular thickness of any homogeneous substance which can be considered as perfectly opaque must depend on its conductivity. It is a question of dissipation, and a minute but specifiable fraction of an original disturbance may be said to get through any obstacle. Practically, however, it is well known that a thin, though not the thinnest, film of metal is quite impervious to light.

When one says that conductivity is not the sole cause of opacity, one is thinking of opacity caused by heterogeneity. A confused mass of perfectly transparent substance may be quite opaque; witness foam, powdered glass, chalk, &c.

Hence, though a transparent body must indeed be an insulator, the converse is not necessarily true. An insulator need not necessarily be transparent. A homogeneous flawless insulator must, however, be transparent, just as a homogeneous and flawless opaque body must be a conductor.

These, then, are the simple connections between two such apparently distinct things as conducting power for electricity and opacity to light which Maxwell's theory points out; and it is possible to calculate the theoretical opacity of any given simply-constructed substance by knowing its specific electric conductivity.

Fate of the Radiation.

To understand what happens to radiation impinging on a conducting body it is most simple to proceed to the limiting case at once and consider a perfect conductor. In the case of a perfect conductor the wheels are connected not even by friction; they are not connected at all. Consequently the slip at the boundary of such a conductor is perfect, and there is no dissipation of energy accompanying it. The blank space in Fig. 38 (vol. xxxvii. p. 345), represented a perfectly conducting layer. Ethereal vibrations impinging on a perfect conductor practically arrive at an outer confine of their medium: beyond there is nothing capable of transmitting them; the outer wheels receive an impetus which they cannot get rid of in front, and which they therefore return back the way it came to those behind them with a reversal of phase: the radiation is totally reflected. It is like what happens when a sound-pulse reaches the open end of an organ-pipe; like what happens when sound tries to go from water to air; like the last of a row of connected balls along which a knock has been transmitted; and our massive elastic wheels are able to represent the reversal of phase and reflection quite properly.

The reflected pulses will be superposed upon and interfere with the direct pulses, and accordingly if the distances are properly adjusted we can have the familiar formation of fixed nodes and stationary waves.

The point of main interest, however, is to notice that a perfect conductor of electricity, if there were such a thing, would be utterly impervious to light: no light could penetrate its outer skin, it would all be reflected back: the substance would be a perfect reflector for ethereal waves of every size.

Thus with a perfect conductor, as with a perfect non-conductor, there is no dissipation. Radiation impinging on them is either all refracted or some reflected and some transmitted. It is the cases of intermediate conductivity which destroy some of the radiation and convert its ethereal vibrations into atomic vibrations, *i.e.* which convert it into heat.

The mode in which radiation or any other electrical disturbance diffuses with continual loss through an imperfect conductor can easily be appreciated by referring to Fig. 43 again. The successive lines of slip, A B C D, E F G H, &c., are successive layers of induced currents. An electromotive impulse loses itself in the production of these currents, which are successively formed deeper and deeper in the material according to laws of diffusion.

If the waves had impinged on one face of a slab, a certain fraction of them would emerge from the other face—a fraction depending on the thickness of the slab according to a logarithmic or geometrical-progression law of decrease. OLIVER J. LODGE.

(*To be continued.*)

PRESENT POSITION OF THE MANUFACTURE OF ALUMINIUM.

THE recent opening of new works for the manufacture of aluminium at Oldbury, near Birmingham, is distinctly an epoch in the history of this interesting metal.

The first practical steps for the manufacture of aluminium were taken in France, following the discoveries of Wöhler and of Deville, and that country has retained the monopoly of its production up to the present time. Aluminium was first obtained in a pure state in the year 1854 by St. Claire Deville whilst working in the laboratory of the Normal School, Paris, with a totally different object. Some pounds of this metal which were shown at the Paris Exhibition of 1855 had been made at the chemical works of Javel; subsequently larger plant was put up at some works at Glacière; later on we find the manufacture in an improved form transferred to Nanterre; and soon afterwards it was removed to the position in which it has ever since remained, viz. at Salindres, at the works at that time belonging to Messrs Merle and Co., but now carried on by Messrs. Pechiney and Co.

Shortly after Deville obtained aluminium by reducing the chloride with sodium, he also succeeded in isolating it by electrolyzing the double chloride of aluminium and sodium in a state of fusion. Many attempts have been made to improve this method, but although within the last year or two works have been put up both in Germany and in France which are stated to be able to produce aluminium at a comparatively cheap rate, there is no trustworthy evidence to show that they can compete with the sodium process. On the face of it there appears no reason why aluminium should not be economically manufactured in this way, since it is an undoubted fact that it can be done in the case of magnesium. There are, however, difficulties in getting aluminium to deposit in a satisfactory condition which do not occur with magnesium.

Recently, by applying electricity in a totally different way, alloys of aluminium have been manufactured on a comparatively large scale in America by Messrs. Cowles Bros. Works for the purpose are also being opened by them in England. This process, it will be remembered, consists in passing a powerful current between two carbon electrodes embedded in a mixture of alumina, charcoal, and the other metal required for the alloy. By this process aluminium in an unalloyed form has not yet been obtained, at any rate commercially.

Some fourteen years ago, Messrs. Bell Bros., of Newcastle-on-Tyne, erected works to manufacture aluminium by means of sodium; but, after incurring great expense, they abandoned the attempt, partly owing to difficulties experienced in obtaining it sufficiently pure for the manufacture of alloys, and partly because they were unsuccessful in getting it used on a sufficiently large scale. Another factory put up in Berlin was similarly abandoned, almost as soon as erected.

In America, a few years ago, Colonel Frismuth sold aluminium, which, he stated, was made by an improved sodium process of his invention; he did not, however, reduce the price, and his claims have not been substantiated. The same thing may be said of the Aluminium Company which was started about the same time in this country to work the patents of Mr. Webster, of Birmingham. It is, however, by this Company, after having undergone reconstruction, that the process is now being worked which warrants our opening statement that a fresh epoch has been reached in the manufacture of aluminium.

The process in question is the outcome of experiments commenced some six or seven years ago by Mr. H. Y. Castner in New York. He appears to have come to the conclusion that aluminium could only be satisfactorily produced by means of sodium, and he accordingly commenced work to try and improve and cheapen the manufacture of sodium. Having obtained what he considered sufficiently satisfactory results, he came over to this country about two years ago, and erected experimental works at Lambeth, where, after further trials, he succeeded in demonstrating that he was really able to produce sodium at a much cheaper rate than had before been possible; in fact, it appears he is able to produce sodium at less than 1*s.* a pound, whereas it had previously cost about 4*s.* This success led to the erection of works at Oldbury, which have been recently completed, and are now in successful operation.

In the process hitherto employed to produce sodium, an intimate mixture of carbonate of soda, lime, and charcoal is first calcined at a red heat, and this having been transferred to small wrought-iron cylinders (mercury-bottles or large gas-piping being commonly used), it is heated to about 1500° C., when the metal, having become reduced to the metallic state, distils over, and is condensed in a flat iron mould. In practice, this method is found to be defective both mechanically and chemically.

At least half the ultimate cost of production results from the wear and tear of the furnace, and the destruction of the retorts or cylinders by the comparatively high temperature. Looking at it from the chemical point of view, we find the condition of things almost as bad; little, if any, more than 40 per cent. of the sodium actually in the charge being obtained in the metallic state.

All these difficulties arise from the presence of lime in the charge, the lime being added to stiffen the mixture, and so prevent the charcoal from separating from the soda. But the thickening of the charge, which for one reason is so desirable, is equally objectionable for others. It is the thickening of the charge which necessitates the use of small cylinders and a high temperature: the material being a bad conductor, it could not otherwise be sufficiently heated. Another important difficulty in the old process arose from the presence of carbonic oxide in the gases produced in the reactions. Sodium vapour, when near its condensing-point, reacts upon carbonic oxide, forming a black refractory material which is exceedingly explosive. This is particularly the case with potassium, and is the principal reason why potassium is so much dearer than sodium.

Mr. Castner originated the idea of weighting the particles of carbon, thus doing away with the necessity of adding lime. The practical results of this modification in the method of manufacturing sodium are very far-reaching and important. The charge being perfectly fluid, it is no longer necessary to employ such a high temperature, since there is a continuous circulation of fresh material to the sides of the crucible, where the temperature is sufficiently high to set up the reactions by which the sodium is reduced to the metallic state. For the same reason large crucibles can be used instead of small cylinders. Also, the temperature of the operation being reduced from about 1400° C. to about 800° C., cast iron or cast steel may be used for the containing vessels instead of wrought iron.

The carbon particles are weighted by means of iron. The iron is first obtained in a fine state of division by reducing oxide of iron—"purple ore" being generally used for the purpose—in "producer gas," a mixture of carbonic oxide and hydrogen. The finely-divided iron thus obtained is stirred into molten pitch, which is then cooled and broken up into lumps. The next operation consists in heating these lumps in crucibles, whereby a coke is produced containing carbon and iron in the proportion of about 30 : 70; this material, technically called "carbide," having been ground up very fine, is incorporated with certain proportions of caustic soda and carbonate of soda, and the mixture is charged into large crucibles, where it is heated until the violent effervescence, due to the escape of carbonic acid and hydrogen, which takes place at first, has subsided. These crucibles are provided with holes at the bottom, closed by movable plugs. When the effervescence has ceased, the charge, in a liquid state, is run out into smaller crucibles and transferred to the furnace in which the distillation of the

sodium is to take place. The preliminary heating takes about half an hour, and the actual distillation about an hour and a half.

The lid of the crucible, to which is attached the condensing arrangement consisting of an iron pipe dipping into an iron box, is fixed in the furnace; it has a convex rim which makes a joint with the grooved top of the crucible, with the assistance of a little powdered lime. The crucibles are raised and lowered by means of hydraulic power, the work of removing a crucible from the furnace and replacing it by another being done with great rapidity.

The reaction which takes place may be represented by the formula—

$$6NaHO + FeC_2 = 2Na_2CO_3 + 6H + Fe + 2Na.$$

This formula is made up in reality of several taking place *pari passu*. The main point is that it clearly expresses the final result. It will be observed that no carbonic oxide is given off, and the difficulties already referred to, caused by the presence of that gas, are got rid of. The iron is recovered, and used over and over again by coking it with fresh tar.

It is unnecessary to refer here to the arrangements for the production of the double chloride of aluminium and its reduction by sodium, as no special novelty is claimed for them.

Mr. Castner has shown great technical skill in devising the plant used throughout the works, and they are in every way a great advance on anything of the kind attempted before.

A novel feature is that hydrochloric acid, for the manufacture of the double chloride, is obtained direct by means of pipes from Messrs. Chance's glass-works, which are contiguous, and the carbonate of soda resulting from the operation in which sodium is produced is similarly conveyed to Messrs. Chance's, to be there purified and crystallized.

The estimated possible output of these works is stated to be 500 pounds of aluminium and 1500 pounds of sodium per day. The cost of manufacture of aluminium has hitherto been between 30*s*. and 40*s*. per pound. By Castner's process it is stated that it can be produced at 15*s*. That this is so there is but little reason to doubt; and it is a substantial and important reduction, which will enable aluminium to be used much more largely than has hitherto been possible. Still, before it can be very largely used, the price will have to be further considerably brought down; and it is much to be hoped that Mr. Castner's success will stimulate him and others to work with this end in view.

THE QUEEN'S JUBILEE PRIZE ESSAY OF THE ROYAL BOTANIC SOCIETY OF LONDON.

PROBABLY the last of the Jubilee productions has seen the light by the appearance of an article in the Quarterly Record of the Royal Botanic Society of London for the three months ending March last under the title of "Fifty Years of Economic Botany." The article in question forms the essay to which the Council of the Royal Botanic Society has awarded its gold medal and a purse of fifty guineas. The author is Mr. John W. Ellis, L.R.C.P. It needs only a casual glance to discover how deficient this short essay is, not only in consequence of the numerous omissions of very important plants and products, but also on account of the imperfect information given under many of the headings. Thus the writer tells his readers that China grass and rhea are two distinct fibres furnished by allied plants, the former by *Bœhmeria nivea* and the latter by *B. tenacissima*, while the fact is that China grass and rhea are one and the same thing, *B. tenacissima* being a synonym of *B. nivea*. In a casual reference to "Moong" fibre the author is apparently quite ignorant of the fact that its botanical source is *Saccharum munja*, Roxb. New Zealand flax (*Phormium tenax*) is introduced under textiles, but why is not apparent, for the author concludes his paragraph as follows—"Not having been introduced during the period to which this essay refers, any further mention of this interesting fibre—for which it has frequently been attempted to find a place in the British market—is unnecessary." Why "gun cotton and its derivatives" should occupy a special chapter it is difficult to say, seeing that this explosive substance is not a direct product of the vegetable kingdom; the author however apparently looks upon it as a much more important vegetable product than the species of cinchona, the ipecacuanha, coca, jalap, or the multitude of new drugs that have occupied such a prominent place in men's minds for the last twenty years. The success that has attended the acclimatisation of the cinchonas in our Indian possessions, whither they were introduced some twenty or thirty years since, when there was a great fear lest the supply of bark from South America should fail because of the great demand, and the consequent reduction in the price of quinine from a guinea to its present price of two shillings per ounce, are facts of sufficient importance, one would think, to be noted in any record of the progress of useful plants. And the same might also be said with regard to *Erythroxylon Coca*, considering to what purpose cocaine is now being put, but the author—a member of the medical profession—has apparently a wholesome dread of drugs, and for once has ignored all consideration of them. He seems to have been content to consult very old books for his facts throughout and to have completely passed over modern authorities; consequently his statements are both antiquated and incorrect.

The old name of *Siphonia elastica* is quoted for the Para rubber plant instead of the now better known name of *Hevea brasiliensis*. Balata is referred to *Sapota Mulleri* instead of *Mimusops globosa*, and we read that Mr. Jenman's report on the Balata Forests of British Guiana issued in 1885 "will probably assist in developing a demand for this material," while the fact is that balata has been going down in the estimation of manufacturers since that date in consequence of it having been found not to be durable when exposed to the air; manufactured articles made from it cracked on the surface, and the inner portion lost its tenacity, so that some manufacturers have given up its use entirely. The Dika plant of W. Trop. Africa, which has long been identified with the Simarubeous plant (*Irvingia Barteri*), is referred to under the very old name of *Mangifera Gabonensis*, a genus belonging to the natural order Anacardiaceæ. Again carapa or croupee oil of West Africa is said to be obtained from the seeds of *Carapa guineensis* and crab oil of British Guiana from *Carapa guianensis*. These two were combined by Prof. Oliver under *C. guyanensis* in the "Flora of Tropical Africa" so far back as 1868.

These are only a few illustrations of the general untrustworthiness of the essay, the circulation of which, it is hoped, will not be large.

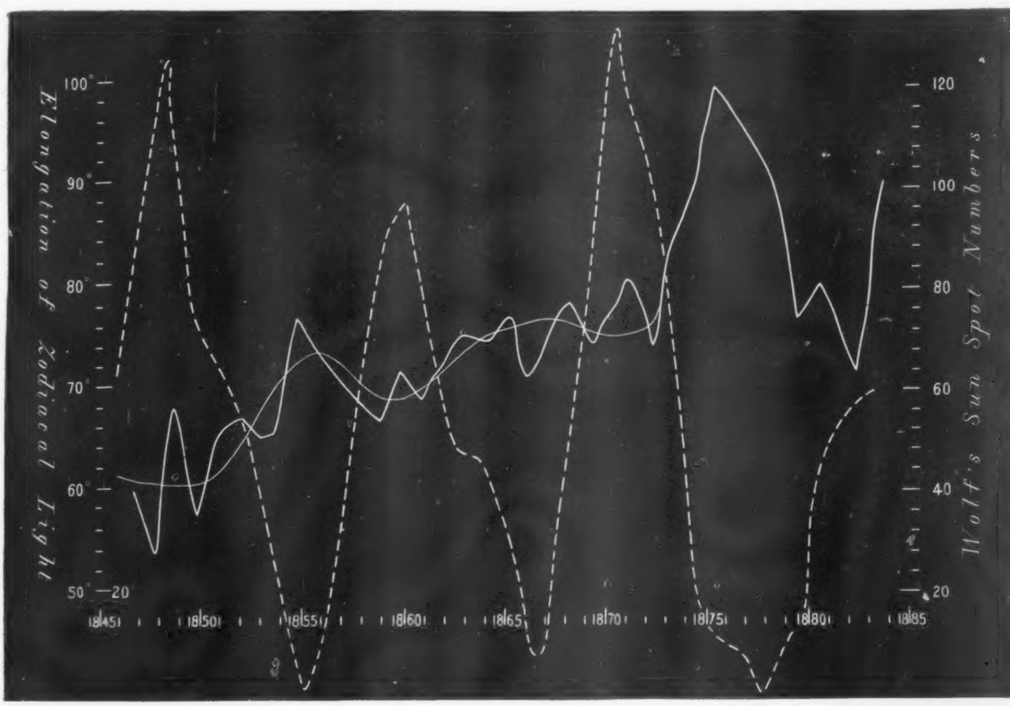
THE ZODIACAL LIGHT.

FROM the days of Cassini a connection between the zodiacal light and sun-spots has been suggested. In some recent discussions it is denied. But, so far as I am able to discover, the long series of observations by Heiss and Weber, extending from 1847 to 1883, afford the first opportunity to attack the question.

The result is in the diagram before you. The broken line represents Wolf's well-known series of relative sunspot numbers, the jagged full line the mean elongations

of the apparent apex of the zodiacal light from the sun. It will be seen that each sun-spot minimum corresponds with a maximum of the zodiacal light, and each sun-spot maximum with a minimum of the zodiacal light. The minimum in 1870 must be considered as masked by the forces tending to produce the enormous maximum of 1876. It will be noticed, too, that when the sun-spot phenomena are more extensive, as in 1850 and 1870, the following zodiacal light phenomena are also more extensive; where the sun-spot phenomena are less, as in 1860, the following zodiacal light phenomena are less extensive; and *per contra*, when the zodiacal light phenomena are extensive, as in 1880, the sun-spot phenomena are less extensive. As far as this series goes, the correlation seems to be complete.

We may gain some insight into the relation by tabulating the various spectroscopic observations in their order in the sun-spot cycle. Thus we have Lias, for four years during the rise in the sun-spot period, observing only a faint continuous spectrum; Respighi and Lockyer, just after sun-spot maximum, one bright line; Vogel, the same; Smyth, Secchi, Pringle, about the same date, no spectrum, or only a continuous spectrum; Tacchini, possibly a bright line; Wright, three years after maximum, generally only a continuous spectrum,—three times a bright line; Burton, fourth year after sun-spot maximum, continuous spectrum; generally a bright line; Arcimis, five years after sun-spot maximum, continuous spectrum and *two* bright lines (1480 K and 2270 K). It would seem, therefore, that the zodiacal light is more gaseous at sun-spot minimum, and only slightly, if at all gaseous, at and near sun-spot maximum.



Comparison of zodiacal light elongations with Wolf's relative sun-spot numbers.

The same story is told by the disturbances suffered by Encke's comet.[1]

We would consider, therefore, the zodiacal light a locus of condensation.

One may notice, too, that the light appears, in common with the frequency of auroræ and the diurnal range of the declination-needle, to be affected by a disturbance of longer period. But for the present we must restrain ourselves from the connections with terrestrial and cosmical physics with which the matter teems, and ask—what is the principal object of this communication—that those who are not observing will observe, and that those who have, or know of the places of concealment of, any observations, will kindly call them to our attention.

Baltimore, Md. O. T. SHERMAN.

[1] ould's Astronomical Journal.

CHEMISTRY AT THE BRITISH ASSOCIATION.

IT was hardly to be expected that the proceedings of the Chemical Section of the British Association would be as remarkable at Bath as at Manchester. Nevertheless, at Bath some interesting discussions took place, and some valuable papers were read.

The President's Address was listened to with great interest, and formed a fitting introduction to the discussion, which afterwards took place, on the teaching of chemistry.

In the "Report of the Committee on the Action of Light on the Hydracids, in Presence of Oxygen," read by Dr. Richardson, some experiments were described, in continuation of those read before the Association last

year. The influence of traces of free chlorine and of moisture on the course of the reaction was investigated.

In connection with the "Report of the Committee on the Properties of Solutions," read by Dr. Nicol, a new apparatus for determining solubilities at temperatures below 100° was shown. Excellent results had been obtained, owing to the very intimate mixture of the salt and solvent.

Dr. Johnstone Stoney exhibited to the Section a diagram illustrating the logarithmic law of the atomic weights. Many curious relations are brought out by its means. If, as seems probable, the logarithmic law be a law of Nature, there appear to be three elements lighter than hydrogen.

Prof. Sterry Hunt, in his paper on "The Study of Mineralogy," advocated a system of mineralogy, based on the successive forms which are imposed upon matter: (1) the chemical form or composition; (2) the mineralogical form, or physical state; (3) the crystalline form, being the most accidental.

Some speculations suggested by Van 't Hoff's hypothesis were put forward by Mr. J. E. Marsh, attention being drawn to certain compounds, which appear to be *geometrical* isomers.

The same author, in another paper, suggested a new constitutional formula for camphoric acid.

On the Friday morning an interesting and well-attended discussion (at which the members of Section D were present) was opened by Prof. Michael Foster, on the "Chemical Problems presented by Living Bodies." In the course of his remarks he suggested several subjects for chemical investigation, such as the exact chemical difference of certain proteids, the changes which occur in the curdling of milk and the clotting of blood, and, to the biologist, the all-important question of the relation in which water stands to the organism.

An animated discussion followed, in which several chemists and biologists took part. In reply to Prof. Thiselton Dyer's question, as to whether the processes employed by chemists had any connection with those which take place in Nature, Prof. Armstrong cited several cases in which the chemical changes occurring in Nature bore a suggestive relation to those brought about in the laboratory.

In their paper on the "Incompleteness of Combustion on Explosion," Prof. H. B. Dixon and H. W. Smith show that, on exploding a mixture of oxygen and hydrogen in a long tube, a considerable residue of gas is obtained, which is still explosive. Experiments were made to arrive at the cause of the phenomenon, and an explanation is suggested.

A new gas-analysis apparatus was shown by Dr. Nicol, which combined the advantages of the Hempel apparatus with the means of using mercury and of readily performing explosions.

Dr. Bott exhibited a modification of a vapour-density apparatus, previously described, which can be employed at any temperature or pressure.

On the Saturday morning Prof. Dunstan read the "Report of the Committee on the Teaching of Chemistry," which was followed by a paper on "Chemistry as a School Subject," by the Rev. A. Irving.

In the ensuing discussion, which was confined to the teaching of chemistry in schools, many of the speakers seemed to agree with the opinions quoted in the report, viz.—

(1) That chemistry should be taught in schools, first, and mainly, on account of the mental training it affords; and, secondly, for the sake of its applications, and its direct bearing on the facts of every-day life.

(2) The chief difficulties met with in teaching seem to be those which arise from (i.) defective organization and considerations of expense; (ii.) the lower value attached to chemistry in comparison with other subjects of the school curriculum; (iii.) the time which is devoted to the subject; (iv.) preparation for various examinations; (v.) absence of good text-books; (vi.) dearth of properly-qualified teachers.

(3) The older plans of teaching are felt to require modification.

The Committee ask for reappointment.

A discussion on "Valency" was opened on Monday by Prof. Armstrong. The question of constant and variable valency was referred to in connection with such compounds as chloroplatinic acid, &c., and a few new terms were introduced. The constitution of such bodies as tetra-methyl-ammonium iodide was considered. Dr. Morley drew attention to the influence which one element in a compound often has in modifying the properties of another not immediately adjacent to it. Chemists were advised to study the facts connected with the question carefully before speculating.

Later on, Mr. Veley described an ingenious arrangement he had invented for studying the action of acids on copper, under simple conditions.

The closing sitting was opened by Prof. Armstrong, who read the "Report of the Committee on Isomeric Naphthalene Derivatives." It was shown that the existence of all the known dichlor-naphthalenes can only be explained by the use of space-formulæ.

In a "Note on the Molecular Weight of Caoutchouc and other Bodies," Dr. J. H. Gladstone and W. J. Hibbert attempted to apply Raoult's method to the determination of very high molecular weights, with fair results.

Some interesting compounds of silicon with thio-carbamide and with aniline were exhibited and described by Prof. Emerson Reynolds, together with several other new thio-carbamide compounds. An account of these exhibits was given in NATURE last week (p. 575).

Dr. Richardson, in his paper on "The Action of Light on Water-colours," drew attention to the very important part played by moisture in assisting their decomposition. Colours are divided into two groups: (1) those which bleach under the combined influence of light, air, and moisture; (2) those on which light exerts a reducing action, which is independent of the air, and in some cases takes place in the absence of moisture.

A paper on "Pyrocresols," by Dr. W. Bott and J. B. Miller, was illustrated by specimens of a large number of derivatives of α-pyrocresol, amongst them being two new azo colouring-matters.

With the reading of this paper the proceedings terminated.

By the courtesy of several chemical manufacturers in the neighbourhood, the members of the Section were enabled, during the course of the meeting, to visit several works where interesting operations were being carried on.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE most important geological work done at Bath this year related to volcanic and earthquake phenomena. Dr. Johnston-Lavis gave an account of the recent eruption in Vulcano, and read the letter which has already appeared in the *Times* from Mr. Narliau, a deeply interested and much-injured witness of the whole occurrence. The chief features seem to have been the ejection of very large blocks to a great distance—one, measuring 10 yards in length, having been found three-quarters of a mile from the crater—and the occurrence of flames, probably caused by the combustion of sulphur deposits. This paper was illustrated by lantern photographs taken by Dr. Tempest Anderson three months before the event. The latter gentleman also exhibited photographs of Vesuvius, Stromboli, and Etna, showing different phases of eruption.

Dr. Lavis presented a report on Vesuvius, describing various new sections cut through the tuffs and lavas of Vesuvius and the Phlegrean fields. The report announced the completion of the author's map of Vesuvius, and claimed to have established that the volcanic activity of the mainland had followed a regular course southwards. The same author announced the discovery of leucite in a lava from Etna, and in another paper attributed the conservation of heat in volcanic chimneys to latent heat set free on the passage of magma from a vitreous to a crystalline condition. Among the other papers were one by Dr. Claypole, who pointed out that in many places, and notably in the Appalachians, strata had been forced up from a depth greater than five miles, the supposed depth of the "layer of no strain"; and one by Mr. Logan Lobley, who attributed (1) the formation of lava to heat in the earth's interior inducing chemical action, (2) its ejection to the expansion due to change from a solid to a fluid state, and (3) explosive eruption to the access of sea- and land-water to the volcanic focus. In the discussion a good deal of misunderstanding seemed to arise from the confusion of "zone of no strain" with "zone of no cooling."

Prof. J. Milne gave tables to show the distribution of Japanese earthquakes in connection with years, seasons, months, and hours of the day. Further tables proved that the majority of earthquakes coincide with a high barometer, and that they are more frequent when the glass is falling or rising, than when it is steady. Earth-tremors are almost always associated with strong wind.

The local interest centred round papers on the Oolitic and Carboniferous rocks. Mr. Horace Woodward united the Cotteswold, Bridport, and Yeovil Sands under the name of Midford Sands; thought that the fullers' earth should be grouped with the Great Oolite which its upper beds sometimes replaced; and preferred to divide the Portlandian in Britain into an upper division, including the Portland, Tisbury, and Swindon *stone*, and a lower division, to hold the Portland Sand and Hartwell Clay.

A very interesting communication from Mr. Whitaker described the occurrence of the Bath Oolite at a depth of 1081 feet in the Streatham boring, the author hoping that the boring would be continued on the chance of meeting some porous rock under this which might have tapped off the Lower Greensand waters. Even if this did not take place, he trusted that the boring might be continued for purely scientific purposes, and as another opportunity of testing the question of coal under London.

Mr. Wethered correlated the Lower Carboniferous limestone of Gloucestershire with the Tuedian and Calciferous series of the north of England; and Mr. Handel Cossham described a series of trial shafts and headings which proved the existence of a reversed fault with very low hade on the northern part of the Bristol coal-field: the effect of the faulting of the strata was nearly to double the known coal resources in the western part of the field. A similar overthrust, bringing Carboniferous limestone to rest in dolomitic conglomerate at Tytherington was described by Mr. Winwood; and Mr. Ussher called in similar faults to explain the position of the Vobster limestone patches in Somerset. The latter author considered the Watcombe terra-cotta clay to be of Triassic age.

There were a few papers on the Archæan rocks, but little that was new was brought forward. Dr. Persifor Frazer considered that the central rocks of the nucleal ranges of the Antilles were Archæan; and Dr. Irving summed the evidence for life in this system, and found it wanting.

Mr. Bell's "Report on the Manure Gravels of Wexford" concluded that these were immediately pre-glacial in age, and that the Killiney gravels, and the marls, clays, and brick-earths of the coast were of later date. Mr. Clement Reid recorded *Betula nana*, *Salix polaris*, and *S. myrsinites* from the lacustrine deposit of Hoxne, to prove that it was formed in a severe climate preceded by a warmer one in which yew, bur-reed, and cornel flourished. A lengthy report from Dr. Crosskey on new erratic blocks in Yorkshire, Essex, Lancashire, and Leicestershire, was followed by a paper on a high-level boulder-clay (700 feet) in the Midlands, in which the same author inclined to the theory that it was floated from the nearest glacier and deposited by ice-foot and ice-bergs. Mr. Shore recorded Neolithic flakes and a hammer-stone found in peat below the tidal alluvium at the Southampton new dock excavation; and Mr. Lamplugh's report on the old subglacial sea-beach at Bridlington gave proof of some remarkable changes in the physical geography of the Yorkshire coast since the time of its formation.

Amongst the palæontological work was Prof. Rupert Jones's "Report on the Palæozoic Phyllopods"; and Prof. Williamson's on the Carboniferous flora, in which the author showed that the central vascular bundle of the Carboniferous Cryptogams contained a germ which developed into a persistent pith, while portions of the medullary tissue assumed the functions of a cambium. Dr. Irving described experiments to show that the vigour of plant life is increased until the percentage of CO_2 in the atmosphere equals the oxygen; and Mr. Whidborne briefly described many new species of Cephalopoda, Gasteropoda, Crustacea, and Conchifera from the Devonian of various localities. An important communication was made by Mr. H. F. Osborn, who traced back the Mammalian teeth to the tritubercular and thence to the triconodont type, and proposed a new nomenclature based on this principle. Prof. Gaudry commented on the gigantic size of some Tertiary Mammalia, Prof. Seeley on an Ichthyosaurus from Africa, and Prof. Marsh on the classification of the Dinosaurs. Mr. Smith Woodward and Prof. Bassani dealt with fish-remains from the Chalk, London Clay, and Lower Miocene.

Among the petrological papers we may note:—Dr. Sterry Hunt on mineralogical evolution, in which the author attempted to correlate chemical resistance with hardness, and this with condensation, in minerals; and to show that the greater stability of those (silicates) which belong to the more condensed types was shown in their superior resistance to decay. Dr. Sterry Hunt concludes that the great successive groups of stratiform crystalline rocks mark necessary stages in the mineralogical evolution of the planet. Mr. Joly decolorized beryl at 357° C., and has discovered twelve-sided basal prisms of iolite in the Dublin granite. Prof. Seeley raised a discussion on Oolitic structure, in which Dr. Gilbert instanced the formation of recent Oolites in the Great Salt Lake. Prof. Blake presented a long report on the Anglesey rocks, in which he described the passage of dolerites into hornblende and glaucophane schists, and then into slate-like rocks; and of gabbros into talcose schists. Mr. Watts described an igneous succession in Shropshire from old acid andesites through younger dolerites into picrites, without any break in the sequence; and Dr. Persifor Frazer exhibited and described some curious specimens of glassy and spherulitic oligoclase and quartz with peculiar optical properties. Though not precisely belonging to this Section, some clay models exhibited and described by Dr. Ricketts may here be mentioned, in which, by vertical pressure in the centre, reversed folds and inverted faulting had been produced. The author attempted to apply this method to explain the folding and cleavage of the Silurian slates in Wales.

NOTES.

SOME time ago Lord Crawford offered to present to Scotland his valuable collection of astronomical instruments at Dun Echt, on condition that suitable accommodation should be provided

for it, and that it should be managed for the public benefit. The Secretary for Scotland, we are glad to learn, has accepted Lord Crawford's offer; and the Treasury has agreed to provide means for the erection of the necessary buildings. A committee of scientific men is engaged in examining different sites around Edinburgh which seem suitable for the erection of a national Observatory; and, according to the Edinburgh Correspondent of the *Times*, the choice seems to lie between the Braid Hills and the Blackford Hill, both of which are on the south side of the city. The same writer says that two proposals have been made for utilizing the old Observatory on the Calton Hill—the one that, after the instruments have been repaired, the place should be used as a popular Observatory; the other, that it should be attached to the Heriot-Watt Technical College for class-work in connection with the lectureship on astronomy there.

THE Mercers' Company, one of the oldest and wealthiest of the City Companies, is thinking of establishing an Agricultural College. A correspondent of the *Times* says it proposes to devote £60,000 to this object. According to the same authority, the intention is that the College shall be in Wiltshire, and that there shall be attached a farm of considerable extent, in which the pupils may practically apply the knowledge they gain, the institution being intended to benefit the sons of farmers and others who will be dependent on the successful culture of land for their future livelihood. The sum of £60,000 contributed by the Company would, it is hoped, be supplemented by a liberal donation from the Charity Commissioners, and the Company would of necessity be prepared to provide an adequate endowment.

THE new laboratories at Trinity College, Dublin, which are now open to all students of chemistry, comprise general laboratories for instruction in elementary chemistry, and quantitative and research laboratories. The latter are provided with all modern appliances, and have special rooms attached for analysis of gas and water, for assaying, and for ultimate organic analysis. The laboratories are under the general direction of Prof. Emerson Reynolds, F.R.S.

A STATUE of Ampère was unveiled on October 9, at Lyons, his native place. The ceremony took place before the President of the French Republic; and M. Cornu, a member of the French Academy of Sciences, delivered an elaborate address, in which he spoke of the importance of Ampère's discoveries.

THE Council of the Institution of Civil Engineers has issued a list of subjects upon which, among others, original communications are invited for reading and discussion at the ordinary meetings, and for printing in the minutes of proceedings of the Institution. For approved papers the Council has the power to award premiums, arising out of special funds bequeathed for the purpose.

THE Society of German Engineers offers a prize of 5000 marks (£250) for the best essay containing a critical estimate of experimental investigations concerning the passage of heat through heated surfaces, in its relation to material, form, and position of the latter, as well as to the kind, temperature, and motion of the heated substances. Competitors are to forward their treatises to the General Secretary of the Society by December 31, 1890.

THE Tokio Mathematical and Physical Society proposes, in order to commemorate the tenth anniversary of its foundation, to award a prize not exceeding 20 *yen* (£4) in value for the best original paper on the properties of the so-called asymptotic curves, and the relations (if any) existing between these curves and straight lines on a surface—in particular, an algebraic surface.

SEVERAL influential Chinese have subscribed large sums of money to aid in establishing a zoological garden at Shanghai. At present the institution will be merely a commercial undertaking, but it is hoped that ultimately the State will take it over. Amongst others, the Governor of Formosa has promised his help in the collection of specimens.

IN the last issue of the Journal of the Russian Chemical and Physical Society there is an interesting article on Prof. S. A. Wroblewski, whose death at Cracow we lately recorded. While a student of the Kieff University, Wroblewski took part in the Polish insurrection of 1863, and was exiled to Siberia, where he had to remain for six years. During his term of exile he elaborated a new cosmical theory, which on his return he hastened to submit to German men of science. Helmholtz received the young man cordially, but advised him to make at the Berlin laboratory certain experiments which would convince him of the erroneousness of his ideas. Wroblewski at once began earnest physical and chemical work, and never afterwards spoke of the theory of his youth. In 1874 he went to Strasburg, and there he published his first serious work, "Ueber die Diffusion der Gase durch absorbirende Substanzen." The flattering opinion expressed about this work by Maxwell in NATURE encouraged Wroblewski to continue physical work on the same lines. He was offered the Chair of Physics at the Cracow University, and the authorities of that institution gave him permission to spend a year at Paris in the laboratory of Sainte-Claire Deville, before beginning his University teaching. There Wroblewski discovered, in the course of his work on the saturation of water with carbonic anhydride under strong pressures, the hydrate of carbonic oxide, and that discovery became the starting-point of a series of works on the condensation of gases. His capital discoveries, made in association with M. Olszanski, which resulted in the condensation of oxygen, azote, and hydrogen, are well known. He was making preparations for an elaborate volume on the condensation of hydrogen, when he perished by accident. While working late in the night in his laboratory, he fell asleep, and in his sleep he overthrew a kerosene lamp. His clothes began to burn, and the wounds thus received resulted four days later in death. The Journal gives a complete list of Wroblewski's works.

AN interesting archæological discovery has been made in the tidal river Hamble, near Botley, Hants. A boathouse is being built at the point of the junction of the Curdridge Creek on the river, some distance above the spot where there is a still existing wreck of a Danish man-of-war. While the mud and alluvial soil were being removed to make sufficient waterway, something hard was encountered, which on being carefully uncovered proved to be a portion of a prehistoric canoe. It is about 12 feet long by 2½ feet wide, beautifully carved, and in a fairly good state of preservation.

THE other day a peasant at Vestervang, in West Jutland, found a splendid piece of amber in a marl pit, weighing 1½ pound.

M. HALLEZ has published, in the first number of the *Revue Biologique du Nord de la France*, an interesting paper on the natural scavengers of various beaches of Northern France. At Boulogne, the species *Nassa*, which is very abundant, performs the useful office of destroying all dead animal relics. At Portel, *Nassa* is scarce, but *Eurydice pulchra* is very abundant, and takes the business in hand. At Cape Alprech, there are neither *Eurydice* nor *Nassa*, but *Ligia oceanica* fulfils their duties. At Equihen, these duties are undertaken by numerous *Orchestiæ*. It is worth noting that these four points are quite close to each other.

THE chemistry of the modern advantageous method of manufacturing chloroform from acetone and bleaching-powder has

formed the subject of the successful researches of Messrs. Orndorff and Jessel. The first stage of the reaction is found to consist in the formation of methyl chloral, $CH_3 . CO . CCl_3$, which is subsequently acted upon by the hydrate of calcium formed at the same time, with production of chloroform and calcium acetate. The changes are expressed by the following equations:—

$$2CH_3 . CO . CH_3 + 6CaOCl_2 = 2CH_3 . CO . CCl_3 + 3Ca(OH)_2 + 3CaCl_2 ;$$
$$2CH_3 . CO . CCl_3 + Ca(OH)_2 = 2CHCl_3 + Ca(C_2H_3O_2)_2.$$

Calculated from these equations, the yield of chloroform should be 206 per cent. of the weight of acetone employed. As a matter of fact, the process has now reached such a state of perfection that as much as 188 per cent. is actually obtained in the best manufactories.

ANOTHER rich yield of new organic compounds has been obtained by M. Paul Adam by an application of the famous aluminium chloride reaction to the hydrocarbon diphenyl, $C_6H_5 . C_6H_5$. The number of new substances which have been synthesized by use of this reaction since its introduction by Messrs. Friedel and Crafts must now be enormous, and its value in assisting the completion of the fabric of descriptive organic chemistry cannot be over-estimated. The method of treatment consists in mixing the substance to be acted upon, in this case diphenyl, with aluminium chloride in a flask connected with an inverted condenser, to the end of which is attached a bent tube arranged so as to dip beneath the surface of mercury. If necessary, just sufficient heat is applied in order to keep the mixture in the liquid state; when this is effected the haloid compound of the radical to be introduced is allowed to slowly enter from a dropping funnel. Hydrochloric or hydrobromic acid is at once disengaged, the gas coming off steadily and readily indicating the progress of the reaction, which results in the substitution of the radical for hydrogen of the original substance. On completion of the reaction it is only necessary to place the mass in water, so as to decompose the aluminium chloride, when the black liquid becomes decolorized and the new substance separates as a colourless liquid or crystalline solid. When methyl chloride, CH_3Cl, is allowed to act in this way upon diphenyl in presence of aluminium chloride, M. Adam finds that the chief product is methyl-diphenyl, $C_6H_5 . C_6H_4 . CH_3$, in which the methyl group occupies the meta position. This new body is a highly refractive colourless liquid, boiling about 271°–277° C., and remaining liquid as low as −21°. It is isomeric with Dr. Carnelley's para-compound, the only one hitherto known. The ethyl and methyl ethers were readily obtained by the usual methods, and from the latter yellow syrupy substance, $C_6H_5 - C_6H_4 - CH_2 - OCH_3$, was obtained by the action of gaseous hydriodic acid, a highly interesting body, $C_6H_5 - C_6H_4 - CH_2 - OH$, the alcohol of the series, phenyl-benzyl alcohol, a very viscid liquid which eventually crystallized. The mono-methyl derivative, however, was not the only product of the primitive reaction, for M. Adam also succeeded in isolating a dimethyl phenyl, $C_{12}H_8(CH_3)_2$, boiling at 284°–290°. Moreover, a similar series of derivatives were next obtained containing ethyl instead of methyl; and finally the synthesis of the hydrocarbon fluorene, $\left.\begin{matrix}C_6H_4\\ |\\ C_6H_4\end{matrix}\right\rangle CH_2$, discovered by Berthelot in coal-tar, was effected by acting in a similar manner with methylene dichloride, CH_2Cl_2, upon diphenyl in presence of the accommodating aluminium chloride.

AN interesting discussion on "Bird Pests of the Farm" is printed in the current number of the *Zoologist*. All the writers who take part in the discussion agree that the habits of rooks have for some time been undergoing a remarkable change. Formerly, rooks lived chiefly on grubs and worms. Their supply of this kind of food has been greatly diminished by better farming, draining, and other improvements; and at the same time the birds have largely increased in numbers. Consequently they have been obliged to look for new sources of food-supply. They do very serious injury to cultivated crops, and devour enormous quantities of the eggs of game-birds. Mr. H. H. Scott says that during nesting-time, in districts where there are large rookeries, the heather on the moors and the fences in the fields are searched by rooks, yard by yard, for these eggs. Mr. Gilbert Millar, head-keeper to Mr. Creswell, of Harehope Hall, Alnwick, testifies that twenty-five or thirty years ago rooks were rarely known to take eggs; "but," he adds, "they have turned gradually worse every year since then, and now they have become a perfect pest and take all the early nests. Not one out of every twenty early nests that I have known of, these last few years, has escaped them." Pheasants' nests are sometimes built in rookeries, but, oddly enough, they are safer there than outside, as rooks never seem to look for them under their own nests.

AT the general meeting of the Council of the French Meteorological Office, Admiral Cloué, Vice-President, stated that the service of weather forecasts during the past year had reached 90 per cent. of successes, a figure never before surpassed. The number of climatological stations from which reports are regularly received is 143. Among the foreign stations we observe that two are being established in Madagascar. As an encouragement to observers on board ship, sixteen gold medals were presented during the year, for the best log-books received. Telegrams from America are regularly received, and include reports of storms, &c., met by ships in the Atlantic. M. Mascart stated that the work of the Departmental Commissions continued to improve each year, and that now there were only six departments which had not special Commissions. M. Vaussenat gave an interesting account of the observation of thunderstorms and of the photography of clouds and lightning on the Pic-du-Midi, and M. Janssen urged the importance of cloud photography at regular intervals, and of a systematic study of cloud formations and modifications.

THE Meteorological Report of the Straits Settlements for the year 1887 contains, in addition to the usual monthly and annual summaries at the four principal Observatories: (1) a tabular statement of the mean annual and monthly rainfall at Singapore from 1869 to 1887; and (2) charts showing the mean annual range of various elements at Singapore from 1870 to 1887. The year 1887 has presented little that is striking or anomalous. The rainfall of the colony, which is represented by thirty-nine stations, has been more than in the previous year.

THE Royal Society of Tasmania has issued its Papers and Proceedings for 1887. Among the papers we may note the following: description of new rare Tasmanian Hepaticæ, by B. Carrington and W. H. Pearson; on the acclimatization of the salmon (*Salmo salar*) in Tasmanian waters, by W. Saville-Kent; a first list of the birds of Maria Island, by Colonel W. V. Legge; observations with respect to the nature and classification of the rocks of the Tertiary period, more particularly relating to Tasmania, by R. M. Johnson.

MESSRS. MACMILLAN AND CO. have just published the third edition of Lock's "Arithmetic for Schools." Simultaneously with this edition, a key to the work, by the Rev. R. G. Watson, has been issued. Mr. Lock explains that the solutions have been very carefully worked under his superintendence.

THE "Hand-book of Jamaica" for 1888–89, by A. C. Sinclair and L. R. Fyfe, has been issued. It is compiled from official and other trustworthy sources, and includes ample historical, statistical, and general information concerning the island.

A GUIDE to the Caucasus, by E. Weidenbaum, has been published at Tiflis by order of the Governor-General. It contains much archæological information.

WE have received the tenth volume of the third series of the Memoirs, and the first volume of the fourth series of the Memoirs and Proceedings, of the Manchester Literary and Philosophical Society.

THE University College of Liverpool, and the University College of Wales, Aberystwith, have each issued a calendar for the session 1888-89.

MESSRS. LONGMANS AND CO. have in the press the following works:—"A Hand-book of Cryptogamic Botany," by A. W. Bennett and George R. Milne Murray; "A Text-book of Elementary Biology," by R. J. Harvey Gibson; "Force and Energy: a Theory of Dynamics," by Grant Allen; and Part I of "Graphics; or, the Art of Calculation by Drawing Lines, applied to Mathematics, Theoretical Mechanics and Engineering, including the Kinetics and Dynamics of Machinery, and the Statics of Machines, Bridges, Roofs, and other Engineering Structures," by Prof. Robert H. Smith.

MESSRS. CHAPMAN AND HALL will shortly publish "Thirty Thousand Years of the Earth's Past History," by Major-General A. W. Drayson; and "Marine Engines and Boilers," by Mr. George C. V. Holmes.

AMONG the works announced by Messrs. Sampson Low and Co. are the following:—"Metallic Alloys; a Practical Guide for the Manufacture of all kinds of Alloys, Amalgams, and Solders used by Metal-workers, especially by Bell-founders, Bronze-workers, Tinsmiths, Gold and Silver Workers, Dentists, &c., &c., as well as their Chemical and Physical Properties," edited chiefly from the German of A. Krapp and Andreas Wildberger, with many additions by William T. Brannt; "The American Steam Engineer: Theoretical and Practical, with Examples of the latest and most approved American Practice in the Design and Construction of Steam-Engines and Boilers," for the use of engineers, machinists, boiler-makers, and engineering students, fully illustrated by E. Edwards, C.E.; "Science and Geology in Relation to the Universal Deluge," by W. B. Galloway, M.A., Vicar of St. Mark's, Regent's Park; "Technology of Textile Design: being a Practical Treatise on the Construction and Application of Weaves for all Textile Fabrics, with minute Reference to the latest Inventions for Weaving," containing also an appendix showing the analysis and giving the calculations necessary for the manufacture of the various textile fabrics, by E. A. Posselt, Head Master, Textile Department, Pennsylvania Museum and School of Industrial Art, Philadelphia, Pa.

DR. BIRKBECK HILL, the editor of Boswell's "Johnson," has nearly ready for publication through the Clarendon Press a collection of letters from David Hume to William Strahan, hitherto unpublished. In the preface he recounts the circumstances under which Lord Rosebery purchased the originals when the authorities of the Bodleian and of the British Museum had declined them. A "Life of Hume" has been prefixed, and the letters have been fully annotated.

WE have received a copy of a pamphlet entitled "The Technical Education of Engineers," a course of technical study recommended by the Manchester Association of Engineers to youths engaged in engineering workshops and other mechanical trades. There are practical hints as to the course to be pursued in each subject, and the names of books recommended by the Association are given. The little work, which only costs twopence, should be in the hands of all those for whose aid it was compiled.

THE Botanical Exchange Club of the British Isles has issued its Report for 1887. Mr. Arthur Bennett indicates the new county records in the plants contributed.

MR. SAVILLE-KENT, at present engaged in officially investigating and reporting upon the fish and fisheries of various of the Australian colonies, has accepted an invitation from Captain the Hon. F. C. Vereker and other officers of H.M.S. *Myrmidon*, to join that ship at Port Darwin and to take part in the marine natural history exploration of the northern and north-western Australian coast in association with the survey work now being conducted. Mr. Saville-Kent proceeds *viâ* Brisbane and Thursday Island, taking with him trawls, dredges, and other apparatus suited for the projected work.

THE Committee of the Sunday Lecture Society have decided that during the winter a course of twenty-one lectures shall be given in St. George's Hall, London, on Sunday afternoons, at 4 p.m., as in former years, beginning on October 21.

THE next ordinary general meeting of the Institution of Mechanical Engineers will be held on Wednesday, October 24, and Thursday, October 25, at 25 Great George Street, Westminster. The chair will be taken at 7.30 p.m., on each evening, by Charles Cochrane, Esq., Vice-President, in the absence of the President, Edward H. Carbutt, Esq., who is travelling in America. The discussions will be resumed on the following papers read at the last two meetings in May and August: description of Emery's testing machine, by Mr. Henry R. Towne, of Stamford, Connecticut, U.S.A.; description of the compound steam turbine and turbo-electric generator, by the Hon. Charles A. Parsons, of Gateshead. The following papers will be read and discussed, as far as time permits: description of the Rathmines and Rathgar township water-works, by Mr. Arthur W. N. Tyrrell, of London; supplementary paper on the use of petroleum refuse as fuel in locomotive engines, by Mr. Thomas Urquhart, Locomotive Superintendent, Grazi and Tsaritsin Railway, South-East Russia.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Miss Kate Marion Pope; a Brush-tailed Kangaroo (*Petrogale penicillata* ♂), a Laughing Kingfisher (*Dacelo gigantea*) from New South Wales, presented by Captain Philp; a Gazelle (*Gazella dorcas* ♀) from North Africa, presented by Mrs. Eugenio Arbib; a Brazilian Hangnest (*Icterus jamaicai*) from Brazil, presented by Mr. T. R. Tufnell; five —— Francolines (*Francolinus* —— 2 ♂ 3 ♀) from South Africa, presented by Captain Larmer; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. H. Butler; two Slowworms (*Anguis fragilis*), British, presented by Mr. Cecil L. Nicholson; two Alpacas (*Lama pacos*) from Peru, two Upland Geese (*Bernicla magellanica* ♂ ♀) from the Falkland Islands, three Crested Pelicans (*Pelecanus crispus*), South European, deposited; four Esquimaux Dogs (*Canis familiaris*, var.), a Bennett's Wallaby (*Halmaturus bennetti* ♀), a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SOLAR PARALLAX FROM PHOTOGRAPHS OF THE LAST TRANSIT OF VENUS.—A preliminary value of the solar parallax, as obtained from the measurement of the photographs of the sun taken at the different American stations during the transit of Venus, of December 1882, has been recently published. This value is based upon the measured distances of the centres of the sun and of Venus on 1475 photographs, taken at ten stations, six in the United States, two in South America, and the remaining two at Wellington, South Africa, and Auckland, New Zealand. It compares as follows with the values deduced from the American and French photographs respectively of the transit of 1874:—

American 1882	$\pi = 8''.847 \pm 0''.012$
American 1874	$\pi = 8''.883 \pm 0''.034$
French 1874	$\pi = 8''.80$

The value now found, though probably a close approximation to that which will be afforded by the complete discussion of all

the photographs, cannot be regarded as final, since, amongst other reasons, the reduction of the position-angles of Venus is yet unfinished.

THE MARKINGS ON MARS.—Observations of Mars more recently published tend to throw doubt upon the "inundation of Libya," which M. Perrotin reported some four or five months ago. Not only were Prof. Schiaparelli and Dr. Terby unable to confirm his statement, but M. Niesten at Brussels, and Prof. Holden at the Lick Observatory, failed to remark this change. The observations of Prof. Holden and his assistants did not begin until July 16, and were continued until August 10. The planet was therefore very unfavourably situated when they were made, since the diameter of the planet was always less than 9", and its zenith distance about 60°. Several of the more important canals were seen, but they were not seen double, but appeared rather "as broad bands covering the spaces on M. Schiaparelli's map which are occupied by pairs of canals, and by the space separating the members of each pair." M. Niesten also seems to have failed to see the gemination of the canals, but, in common with other observers, was much struck by the whiteness and brilliancy of some portions of the planet, particularly of *Elysium* or *Fontana Land*, as it is called by Mr. Green. The brightness of Fontana Land has been commented on both by M. Perrotin and Prof. Schiaparelli, and the former observer has recently delineated an intricate network of canals between that district and the north pole, and another yet more complicated on the *Madler Continent*. Prof. Schiaparelli has had to chronicle still stranger changes in this last-named district, which he observed on May 20 under specially favourable circumstances, having been able to distinguish the two banks of some of the canals, the one from the other, and to detect very small undulations in them. He speaks also of the ordinary markings, of gulfs, canals, &c., as disappearing at a given moment, for their places to be taken by grotesque polygons and geminations "which evidently approximately represent the earlier state; but it is a gross, and, I should say, an almost ridiculous mask."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 OCTOBER 21–27.

(**FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.**)

At Greenwich on October 21

Sun rises, 6h. 37m.; souths, 11h. 44m. 35·2s.; sets, 16h. 52m.: right asc. on meridian, 13h. 46·0m.; decl. 10° 57′ S. Sidereal Time at Sunset, 18h. 54m.

Moon (Full on October 19, 21h.) rises, 17h. 43m.*; souths, 0h. 40m.; sets, 7h. 50m.: right asc. on meridian, 2h. 39·3m.; decl. 10° 28′ N.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	8 41 ...	12 56 ...	17 11 ...	14 57·7 ...	19 59 S.
Venus ...	9 13 ...	13 30 ...	17 47 ...	15 31·9 ...	19 38 S.
Mars ...	12 11 ...	15 52 ...	19 33 ...	17 54·1 ...	25 2 S.
Jupiter ...	10 10 ...	14 19 ...	18 28 ...	16 20·4 ...	20 58 S.
Saturn ...	23 58*...	7 26 ...	14 54 ...	9 26·3 ...	18 58 N.
Uranus...	5 37 ...	11 7 ...	16 37 ...	13 8·5 ...	6 37 S.
Neptune..	18 14*...	2 0 ...	9 46 ...	4 0·1 ...	18 50 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich).

Oct.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
23 ...	δ^2 Tauri ...	... 6 ...	2 53 ...	3 59 ...	156 274
24 ...	χ^1 Orionis	... 4½ ...	21 2 ...	21 56 ...	39 264
27 ...	B.A.C. 2854 ...	6 ...	21 59 ...	22 51 ...	46 239

Meteor-Showers.

	R.A.	Decl.	
Near ν Orionis ...	... 90° ...	15° N. ...	The *Orionids.*
From Canis Minor	... 105 ...	12 N. ...	Swift; streaks.
,, Cancer ...	... 133 ...	21 N. ...	Very swift.

Variable Stars.

Star.	R.A.	Decl.			
	h. m.	° ′			h. m.
U Cephei	0 52·4 ...	81 16 N. ...	Oct.	21,	2 51 *m*
			,,	25,	2 30 *m*
Algol	3 0·9 ...	40 31 N. ...	,,	25,	2 51 *m*
			,,	27,	23 40 *m*
S Aurigæ	5 19·7 ...	34 3 N. ...	,,	24,	*M*
R Canis Majoris...	7 14·5 ...	16 12 S. ...	,,	23,	1 59 *m*
S Hydræ	8 47·7 ...	3 30 N. ...	,,	23,	*M*
U Ophiuchi... ...	17 10·9 ...	1 20 N. ...	,,	21,	20 32 *m*
			,,	26,	21 19 *m*
R Scuti	18 41·5 ...	5 50 S. ...	,,	25,	*m*
η Aquilæ	19 46·8 ...	0 43 N. ...	,,	24,	9 0 *m*
S Sagittæ	19 50·9 ...	16 20 N. ...	,,	23,	1 0 *m*
			,,	26,	1 0 *M*
S Delphini	20 37·9 ...	16 41 N. ...	,,	26,	*M*
T Vulpeculæ ...	20 46·7 ...	27 50 N. ...	,,	23,	0 0 *m*
Y Cygni	20 47·6 ...	34 14 N. ...	,,	23,	3 0 *m*
			,,	26,	3 0 *m*
R Vulpeculæ ...	20 59·4 ...	23 23 N. ...	,,	23,	*m*
T Cephei	21 8·1 ...	68 2 N. ...	,,	23,	*m*
δ Cephei	22 25·0 ...	57 51 N. ...	,,	23,	23 0 *M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

To the October number of *Petermann's Mitteilungen*, Dr. J. Hann contributes an important paper, containing a *résumé* of data on the temperature and rainfall of the Japanese islands, and Dr. F. Boas a paper of a similar character on the ice conditions of the south-west of Baffin's Bay.

CAPTAIN WIGGINS has failed to accomplish the voyage to the Yenissei along the north coast of Europe and Asia—mainly, it would seem, on account of the delay caused by his having to wait for another vessel from Europe. Dr. Torell, the well-known Swedish Arctic explorer, who is well acquainted with these seas, maintains that there should be no difficulty in establishing a regular communication between Europe and Siberia along the north-east passage, though he admits that it would be liable to interruption about once in five years. But in order to insure success he states that vessels should be built specially for the work, and that they should go out early in summer and take up their post on the west side of Matotshkin Scharr, in Novaya Zemlya, to be ready to enter the Kara Sea as soon as ever it begins to clear of ice. A railway across Siberia, however, should serve to render any such hazardous trade-route unnecessary, and such a railway is sure to be constructed soon.

A CENSUS of the illiterates in the various countries of the world recently published in the *Statistische Monatschrift*, places the three Sclavic States of Roumania, Servia, and Russia, at the head of the list, with about 80 per cent. of the population unable to read and write. Of the Latin-speaking races, Spain heads the list with 63 per cent., followed by Italy with 48 per cent., France and Belgium having about 15 per cent. The illiterates in Hungary number 43 per cent., in Austria 39, and in Ireland 21. In England we find 13 per cent., Holland 10 per cent., United States (white population) 8 per cent., and Scotland 7 per cent. unable to read and write. When we come to the purely Teutonic States, we find a marked reduction in the percentage of illiterates. The highest is in Switzerland, 2·5; in the whole German Empire it is 1 per cent.; in Sweden, Denmark, Bavaria, Baden, and Würtemberg, there is practically no one who cannot read and write.

IN the October number of the Proceedings of the Royal Geographical Society, the Shah of Persia appears as a geographer. In a paper, annotated by General Houtum-Schindler, His Majesty describes simply, but clearly, the results of his own observations on a new lake, between Kom and Teheran, or rather the reappearance of an old lake, which is said to have dried up in 1357. Whatever may be the history of the lake, there seems little doubt that at one time a large part of Central Persia was covered with water. Mr. H. H. Johnston contributes a short study, from his own observations, of what he calls the Bantu Borderland in West Africa, which is accompanied by a map showing the boundaries of the Bantu and Semi-Bantu races, and also the courses of migration of the two. Another important paper, accompanied by a map, is a translation, by Miss Hay, of Tashkent, of a description of the destructive earthquakes of May and June 1887, in the Vernoe district of Russian Turkestan. Captain Wharton's paper on Christmas Island is given at length.

NOTES ON METEORITES.[1]

V.

WE shall see next that another line of thought and inquiry was required to completely establish the cosmical hypothesis by giving us data as to the *velocities* of the meteorites.

This was that the sporadic meteors, those which made their appearance by chance, so to speak, were always more numerous in the morning than in the evening hours, and further that the numbers seen in the northern hemisphere in one half year was greater than that seen in the other. These facts, although at first they seemed to connect these phenomena with our terrestrial hours, and therefore were at first considered to militate against the cosmical hypothesis, were subsequently shown, by Bompas, A. S. Herschel, H. A. Newton, and Schiaparelli, to be a distinct proof that the bodies were moving in space with a velocity not incomparable with, but at the same time somewhat greater than, that of the earth itself; that therefore they were moving with planetary velocities, and therefore were truly members of the solar system.

The work of M. Coulvier-Gravier[2] was the first to indicate the extreme regularity with which the numbers increased from sunset to sunrise, as will be seen in the accompanying table:—

Time of Observation.	Number seen per hour.	Time of Observation.	Number seen per hour.
5 p.m.– 6 p.m.	... 7·2	12 –1 a.m.	... 10·7
6 p.m.– 7 p.m.	... 6·5	1 a.m.–2 a.m.	... 13·1
7 p.m.– 8 p.m.	... 7·0	2 a.m.–3 a.m.	... 16·8
8 p.m.– 9 p.m.	... 6·3	3 a.m.–4 a.m.	.. 15·6
9 p.m.–10 p.m.	... 7·9	4 a.m.–5 a.m.	... 13·8
10 p.m.–11 p.m.	... 8·0	5 a.m.–6 a.m.	... 13·7
11 p.m.–12	... 9·5	6 a.m.–7 a.m.	... 13·0

It was the dependence of these phenomena upon certain terrestrial hours which made that eminent observer decline to consider their origin as in any way cosmical.

Mr. Bompas,[3] commenting on the numbers obtained by Coulvier-Gravier, wrote—

"The part of the heavens towards which the earth is moving at any time is always six hours from the sun. At 6 a.m. the observer's meridian is in the direction of the earth's motion; and at 6 p.m. in the opposite.

"Thus the greatest number of meteors are encountered when the observer's meridian is in the direction of the earth's motion, and the number diminishes from thence to 6 p.m., when he looks the opposite way."

The accompanying wood-cut will make this clear. The front half of the earth ploughing its way through space is unshaded; an observer is being carried along the line of the earth's motion at sunrise, the earth is behind him, so to speak, and the point towards which the earth is travelling lies 90° in longitude behind the sun.

Combining these facts, Bompas explained the results on the principle that if the meteors be distributed equally in space they would converge to the earth, if at rest, equally on all sides. But if the earth be in motion, and with a velocity one-half the average velocity of the meteors, they would converge to it more on the side towards which it is moving than the other: and in the proportion of nearly two-thirds of the number, would have an apparent motion more or less opposed to that of the earth, and apparently diverging from the point towards which the earth is moving, with a gradual increase in number from 6 p.m. to 6 a.m.

Before we proceed to show the bearing of this matter, a word must be said with regard to the actual conditions under which these bodies reach us from space, and how the fall of these bodies upon the earth and their appearance in the heavens even in the case of no fall have been investigated.

To approach the proof of the cosmical hypothesis afforded by these observations, we may begin by supposing the earth at rest. If the movements of the cosmical particles are in all directions, they will fall equally on all parts of the earth, and even the earth's *rotation* will make no difference. But if we assume the earth's movement in its orbit to be much more rapid than the movements of the meteorites, it is clear that its forward half will receive blows while the hinder half cannot.

Suppose that all the regions of space swept through by the earth in its orbit round the sun were occupied here and there by meteorites, also like the earth moving in orbits round the sun, and let us assume for the moment that they are pretty nearly equally distributed and are moving in all directions.

Under these circumstances the earth in movement in its orbit, at the rate of about 1000 miles a minute, would be sweeping through them all the year round, and we should get the appearance of a shooting-star or the fall of a meteorite every day in the year. Careful observations in climates most convenient for these researches, where the sky is freest from cloud and is purest, show, as we have seen, that there is not only no night but no hour without a falling star. We are therefore justified in considering that practically the part of the solar system which is swept through by the earth is not a vacuum, not empty space, but space peopled with meteorites here and there.

If these meteoritic bodies are equally distributed and are going in the same direction as the earth, but moving more quickly, they would follow and catch the earth; if they were travelling in the same direction as the earth, but more slowly, we should overtake them, and the two sides of the earth separated by a plane at right angles to the tangent to the part of the orbit along which it is moving at the time (see Fig. 10) would experience a different condition. One side would be bombarded by the greater number of meteorites in the former case, while in the latter the forward half only would be affected. The assumption, however, is that they are travelling in all directions; hence the numbers which fall on the front hemisphere compared with those that fall on the opposite one—in other words, the numbers seen at sunrise as compared with those seen at sunset—must depend wholly on the velocity of the earth as compared with the mean velocity of the meteorites.

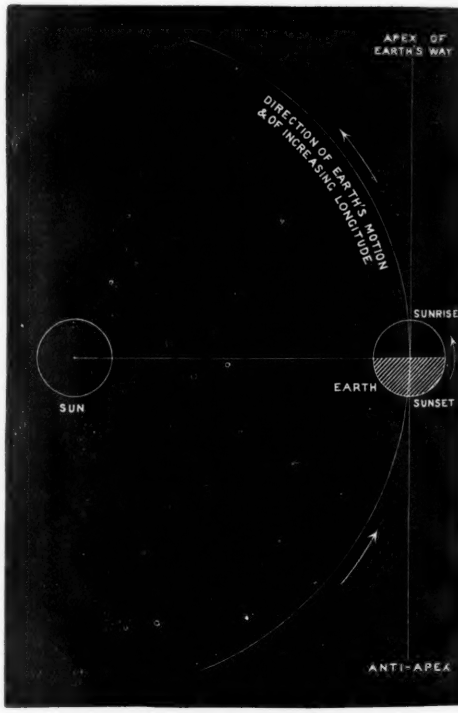


FIG. 10.

The point of space towards which the earth is travelling at any moment, shown in Fig. 10, has been called "the apex of the earth's way"; the point of space it is leaving the "anti-apex."[1]

[1] Continued from p. 559.
[2] "Recherches sur les Météores," p. 219 (Paris, 1859).
[3] *Monthly Notices*, vol. xvii. p. 148.

[1] These terms were suggested by Prof. Pritchard. In 1866, Schiaparelli suggested *point de mire*. Quite recently, Prof. Newton, of Yale, has suggested "goal" and "quit."

The apex of the earth's way is always 90° of longitude behind the sun.

Having, then, this general view of the movement of the earth in her orbit, we are in a position to discuss Mr. Bompas's argument, and we cannot do better than use the explanation given by Prof. Pritchard to the Royal Astronomical Society in 1864,[1] which really possesses an historical interest.

"Our object is to show that this hypothetical uniformity of distribution, combined with the direction and amount of the earth's motion, will have a very sensible effect on the number of meteors actually visible at a given place, at a given hour of the night, as explained (in a somewhat different way) by Mr. Bompas [and at a given season of the year, as extended by Mr. Herschel].

"For the purpose of illustration, suppose H O R (Fig. 11) to represent a flat umbrella, of which N O is the stick; suppose, also, rain to fall upon it equally, and in all directions: then, if the umbrella be at rest, as much rain will fall upon its front, looking from Z, as on its back, from N.

"But now suppose the umbrella itself has a motion from O to E in a given time, and, for the simplicity of first conception, let O E represent also the uniform velocity of the rain: very much more rain will now fall on the front of H O R, and much less on the back of H O R, than before. In fact, if O m be taken = O E,

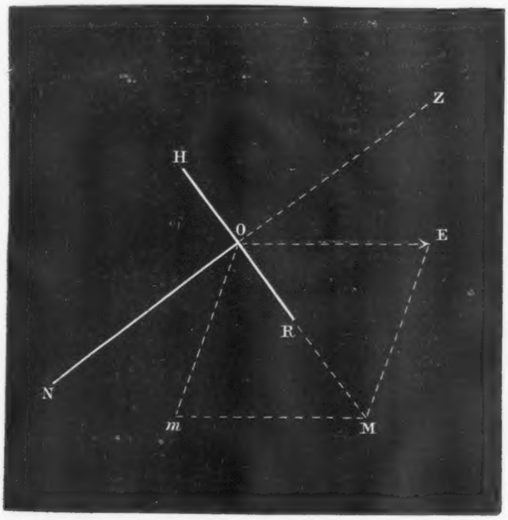


FIG. 11.

and the angle m O R be made = R O E, and the parallelogram m E be completed, then a raindrop, of which m's real path is M E, would, by the motion of H O R, just graze along the front surface of H O R in the direction M R O, when it arrives at E. Moreover, all the rain which at the beginning of the motion was moving within the angle m O R, which would have fallen on the back of H O R at rest, will now fall on the front of H O R, if in motion.

"The application of this hypothetical case to that of meteors is obvious. H O R now represents the horizon, Z the zenith of an observer, and O E the direction and magnitude of the earth's orbital motion. The earth's diurnal motion of rotation is comparatively too small to be taken into account for our present purposes. So long, then, as O E, the direction of the earth's orbital motion, is in front of the horizon of an observer, there will thereby occur to him an additional flow (and partial combustion) of meteors against the earth's atmosphere above him; and this increased flow will become the greater as the angle R O E becomes greater. If O E be below H O R, then the number of visible meteors will thereby be diminished."

Now, if we refer to Fig. 10 we shall see that the observer does not reach the forward part of the earth (with reference to the apex of the earth's way) till midnight, and that the apex rises gradually till it is on his meridian at sunrise.

[1] *Monthly Notices*, 1864, vol. xxiv. p. 138.

Here, then, is the reason why the number increases from sunset to sunrise, based upon the theory of their cosmical origin, and really explainable in no other way.

Now for the yearly conditions as revealed by observation.

Dr. Julius Schmidt, the Director of the Observatory at Athens, observed, between the north latitudes of 49°·5 and 54°·2, during eight years from 1843 to 1850, on an average 470 meteors in every year. These were distributed among the several months as follows, taking an average of the entire series:—

Month.	Shooting-stars.	Total Shooting-stars.
July	49	
August	188	
September	41	... 400
October...	37	
November	54	
December	31	
January	17	
February	5	
March	11	... 70
April	11	
May	12	
June	14	
	Total ...	470

Prof. A. Herschel was the first to point out that this yearly difference, as well as the daily difference in the hourly numbers, arrived at by Coulvier-Gravier, demonstrated the cosmical origin.

In 1864 he wrote as follows, assuming that the meteorites travelled faster than the earth:—[1]

"A season of frequency of aërolites, shooting-stars, and bolides, must be expected to succeed, in all latitudes, three months later than the summer season of the sun; but, on the other hand, a dearth of meteors, in the spring, one quarter of a year later than mid-winter. In general, and in all latitudes, the meteoric seasons, or seasons of meteoric frequency, must strictly follow the tropical seasons, and three months later in the year. Thus, in the earth's northern hemisphere, the Northern Pole remains directed to the sun from the equinox of March until that of September, and to the course of meteors from the solstice of June to the solstice of December. The greatest frequency of the meteorites will fall about the equinox of autumn, in September and October. This most nearly agrees with the European observations. The meteoric season of Arago may, therefore, be drawn as a consequence from his planetary hypothesis, if it be permitted to change the limits which he assigns to it by a small quantity—namely, from the Earth's apsides to its solstices in its orbit.

"The same fact, which appears strongly marked with regard to shooting-stars in the eight years' summary of Dr. Schmidt, is found repeated in a striking manner in the existing 'Northern Catalogues of Star-showers, Fire-balls, and Aëroliths.' The following references may be taken as examples:—

Appearances.	Number—July to December.	Number—January to June.
Star-showers from 1800 B.C. In M. Quetelet's catalogue ("Physique du Globe," 1861)	72	28
Aerolitic meteors, from the Christian era. In Mr. Greg's catalogue (British Assoc. Report, 1860) . .	216	186½
Large and small fire-balls. In same catalogue (*ibid.*) .	843	553."

It was now pointed out, by Newton[2] and Schiaparelli,[3] that, provided the actual facts of the daily and yearly variation were sufficiently assured, the true velocities of these bodies in space could not be just simply similar to the earth's velocity, nor their paths in space planetary orbits like that of the earth, and of about the same dimensions; but that as their motion was much faster their orbits would be variously distributed parabolas, and they would consequently be more akin to comets.

That the movement was really much faster was argued in

[1] *Monthly Notices*, vol. xxiv.
[2] *Silliman's Journal*, vol. xxxix., 1865; *Nat. Acad. Sci.*, vol. i.; *Annuaire de l'Observatoire de Bruxelles*, 1866, p. 201.
[3] *Les Mondes*, vol. xiii.

1865, from the duration of the flight of shooting-stars, by Prof. Newton.[1]

From Wartmann's observations of the duration of the flights of 368 shooting-stars at Geneva during one night by six observers, a mean was found of 0·49s. for each flight. The mean of 499 estimates made in August and November 1864 is 0·418s. The mean duration of the 867 flights is 0·45s.

Prof. Newton remarks:—"A mean duration of half a second, and a mean length of path between 39 and 65 kilometres, imply a mean velocity between 78 and 130 kilometres per second. The smallest of these (more than 48 miles) is twice and a half the velocity of the earth in its orbit about the sun. This cannot consist with the supposition that most of the meteoroids move in closed orbits about the sun."

Both the briefness, however, of this assumed duration, and even the least limit, accordingly, of the velocity so found, were presumed by Prof. Newton to be probably overrated.

The final step in this demonstration was taken by Schiaparelli, but before this Newton had distinctly shown that most of the meteors visible were not single in their movements round the sun, but that they belonged to systematic streams and that these streams were not rings.

With special reference to the November ring, Prof. Schiaparelli[2] came to the conclusion that the orbit, instead of being nearly circular, as Newton had at first supposed, was very elongated, like those of comets; and Prof. Adams[3] demonstrated shortly afterwards that, among several possible periods of the stream which Prof. Newton had already indicated, the true period was 33·25 years, the demonstration depending upon the increase of the longitude of the node by the action of the planets Jupiter, Saturn, and Uranus, the calculated increase amounting to 28′, while the actual increase was 29′, and he gave the following elements of the orbit of the swarm—

Period	33·25 years (assumed)
Mean distance	10·3402
Eccentricity	0·9047
Perihelion distance...	0·9855
Inclination	16° 46′
Longitude of node	57·28
Distance of perihelion from node...	6·51
Motion retrograde.	

Aided by considerations suggested by observations of the conditions under which the meteors were observed—from a particular part of the sky, in a particular part of the earth's orbit, at a particular time and from a particular point of the earth's surface, we can understand at once that it was as practicable to determine the orbit of the swarm as it is to determine the orbit of a planet or of a comet.

The final step taken by Schiaparelli, to which we have referred, was a demonstration that the orbits of certain of these streams or swarms, to which reference has been made, were really identical with the elements of known comets.

Schiaparelli computed the elements of the orbit of the August meteors, supposing them to be moving along a cometary or parabolic orbit. For his calculations the data were the radiant in R.A. 44°, N. Decl. 56°, the time of the earth passing near the centre of the group in 1866, August 10·75. With the elements thus obtained he found those of the comet 1862 III., according to the latest determinations by Oppolzer,[4] to be nearly identical, as is seen in the following statement:—

	Elements of August Meteors.	Elements of Comet 1862 III.
Long. of perihelion	343° 38′ ...	344° 41′
Long. of node	138 16 ...	137 27
Inclination	64 3 ...	66 25
Perihelion distance	0·9643 ...	0·9626
Motion	retrograde ...	retrograde
Perihelion passage	July 23·62 ...	Aug. 22·9, 1860
Period		123·4 years

As remarked by Prof. Newton,[5] we come thus to the unexpected conclusion *that the comet of* 1862 *is nothing else than one of the August meteoroids, and probably the largest of them all.*

[1] *Silliman's Journal*, vol. xxxix. p. 203.
[2] *Bulletino Meteorologico dell' Osservatorio del Collegio Romano*, vol. v. 1866.
[3] *Monthly Notices*, vol. xxvi. p. 247, April 1867.
[4] *Astr. Nach.*, No. 1384.
[5] *Silliman's Journal*, vol. xliii., 1867.

When this relation of the comet of 1862 with the August meteors was discovered by Schiaparelli, no comet was known having similar relations with the November meteors. Oppolzer, however, shortly after,[1] published a corrected orbit of comet 1866 I., and the resemblance of its elements to those of the orbit of the November group was at once obvious, and attracted the attention of several astronomers.[2] The following table gives the details:—[3]

	Nov. Meteors.		Comet 1861 I.
Perihelion passage ...	Nov. 10·092, 1866	...	Jan. 11·160, 1866
Passage of descending node	" 13·576		
Long. of Perih. ...	56° 25′·9	...	60° 28′·0
" " asc. node ...	231 28·2	...	231 26·1
Inclination	17 44·5	...	17 18·1
Perihelion distance ...	0·9873	...	0·9765
Eccentricity	0·9046	...	0·9054
Semi-major axis ...	10·340	...	10·324
Periodic time	33·250	...	33·176
Motion	retrograde	...	retrograde

Since this discovery of Schiaparelli's, one by one the various star showers have been shown to be due to meteorite swarms pursuing generally elliptic orbits round the sun, which orbits are identical with those of various known comets. Hence each "radiant point" is already, or will subsequently be, associated with a comet.

Distribution of Meteorites in the Solar System.

The *vide planétaire* is now ultimately abolished, and we find the solar system to be a meteoritic *plenum* in which sporadic meteorites and swarms of greater or less density are moving in orbits more or less elongated round the sun.

The demonstration that meteorites are extra-terrestrial bodies has been followed by researches which, as they have become more complete and searching, have gradually driven men of science to increase their estimates, till at last the numbers acknowledged to exist in what was formerly supposed to be empty space have become enormous.

First as to the sporadic meteorites.

Observations of sporadic falling stars have been used to determine the average number of meteorites which attempt to pierce the earth's atmosphere during each twenty-four hours. Dr. Schmidt, of Athens, from observations made during seventeen years, found that the mean hourly number of luminous meteors visible on a clear moonless night by one observer was fourteen, taking the time of observation from midnight to 1 a.m.

It has been further experimentally shown that a large group of observers who might include the whole horizon in their observations would see about six times as many as are visible to one eye. Prof. H. A. Newton and others have calculated that making all proper corrections the number which might be visible over the whole earth would be a little greater than 10,000 times as many as could be seen at one place. From this we gather that not less than 20,000,000 luminous meteors fall upon our planet daily, each of which in a dark clear night would present us with the well-known phenomenon of a shooting-star.

This number, however, by no means represents the total number of sporadic meteorites that enter our atmosphere, because many entirely invisible to the naked eye are often seen in telescopes. It has been suggested that the number of meteorites if these were included would be increased at least twenty-fold; this would give us 400,000,000 of meteorites falling in the earth's atmosphere daily.

If we consider only those meteorites visible to the *naked eye* as sporadic meteors or falling stars, and if we further assume that their absolute velocity in space is equal to that of comets moving in parabolic orbits, Prof. H. A. Newton has shown that the average number of meteorites in the space that the earth traverses is in each volume equal to the earth about 30,000. This gives us as a result in round numbers that the meteorites are distributed each 250 miles away from its neighbours.[4]

[1] *Astr. Nach.*, No. 1624
[2] Peters, *Astr. Nach.*, No. 1624; Oppolzer, *ibid.*, No. 1626; Schiaparelli, *ibid.*
[3] *Bulletino Meteor.*, February 28, 1867.
[4] Article "Meteorites," Prof. Newton. "Encyclopædia Britannica," 9th edition, vol. xvi.; and "Abstract of a Memoir on Shooting-Stars," by Prof. Newton (*Silliman's Journal*, vol. xxxix., 1865).

Next as to systematic meteorites, those, that is, that are massed in swarms.

Much still remains to be done before their greater density is known. Prof. Newton has calculated that in the Biela swarm the meteorites are thirty miles apart.

J. NORMAN LOCKYER.

(*To be continued.*)

DR. JANSSEN ON THE SPECTRUM OF OXYGEN.

THE following is an abstract of the account given by M. Janssen, in Section A of the British Association, of his researches into the different forms of oxygen, in the direction of an inquiry into the molecular constitution of that element. These experiments have been made in the laboratory which has been organized under Dr. Janssen's supervision, and at the expense of the French Government, at Meudon. The hall in which the observations have been carried out is 100 metres in length. It contains every requisite for studying the optical properties of gases; principally instruments so constructed that a long column of gas may be examined under a high pressure. One of these is a set of steel tubes varying in length from 0·42 metres to 60 metres, terminated at each end by a glass plate, perpendicular to their axes, and constructed to resist a pressure of 200 atmospheres. The chief result of this work was the discovery of a new law of the selective absorption by oxygen of any beam of light, quite independently of its origin, whether from the sun or the electric light. It was proved that oxygen produces two kinds of absorption-phenomena on the spectrum of the light—first, the known rays; and, secondly, a system of dark bands which had not, up to this time, been noticed. M. Janssen has demonstrated that the intensity of the rays varies as the products of the length of the column into the density; while that of the bands varies as the products of the length of the column into the square of the density. The principal results obtained by M. Janssen are best displayed in the following table :—

1. Metres.		2. Atmospheres.		3. Atmospheres.		4. Atmospheres.
60	...	6	...	6	...	6
20	...	10 to 12	...	10·4	...	18
5	...	23	...	20·7	...	72
1·47	...	38	...	38·3	...	240
0·75	...	50 to 55	...	53·6	...	480
0·42	...	70 to 75	...	71·7	...	858

1. Length of the tube.
2. Pressure observed.
3. Pressure calculated by formula Ld^2 (product of length of column into the square of the density).
4. Pressure calculated by the formula Ld.

These numbers are fixed by the point at which the band in the yellow first appears, this phenomenon supplying the standard term of comparison. It is easy to see how nearly the observed results in the second column agree with the figures in the third, and how far they differ from those in the fourth. The law of the square has been discovered by an analytical method, which will be published in full in the Proceedings of the British Association. Dr. Janssen has proved the exactness of this law in its application to the oxygen contained in the atmosphere, in measuring the altitude of the sun necessary for the first appearance of the band. He verified the same law by experiments on oxygen in its liquid state, and found that a thickness of 4 to 5 millimetres was sufficient. The correctness of this law must be considered as valid from 0 to 700 atmospheres. For the flutings of the group B the law of variation according to the formula Ld has been verified from 0 to 100 atmospheres by direct observation of the tubes. It is curious to notice how by the systematic variation of length of column and density it is possible to obtain either lines without bands, bands without lines, or bands and lines together. Among the astronomical applications of this law it is noted that a nebula which might have a diameter of 2000 times the distance of the earth from the sun, containing oxygen at a density of one-millionth of an atmosphere, could be traversed by the light of a star without causing the appearance of oxygen-bands in the spectrum. M. Janssen stated that he is still pursuing these investigations, and others attendant thereon, relative to the molecular construction of oxygen and its presence in the atmosphere of the planets.

At the conclusion of Dr. Janssen's paper, Sir Wm. Thomson recapitulated the main facts to the audience, stating his opinion that the discovery of the law of the square of the density was a most brilliant achievement.

THE GROWTH OF ROOT-CROPS.[1]

THIS is a pamphlet of extremely closely written matter, which purports to be a lecture delivered on July 27, 1887, to agricultural students in Cirencester College. Viewing it as a lecture we should accord it qualified praise, because a lecture must be regarded as oral instruction, and ought to be sufficiently dilute and sufficiently *moist* to allow of the process of mental deglutition. The pamphlet is really a treatise upon the effect of fertilizers on the growth of roots and their composition, and it would be presumption on our part to do more than bow respectful acquiescence to each statement made by so learned and so experienced a specialist.

Dr. Gilbert has studied turnips ever since 1843, and probably long before then, and his knowledge of their habits, their requirements, and their uses, is unequalled by that of anyone else in this country. Anyone who will read through the pamphlet now before us will find his ideas with regard to these esculents enlarged and dignified. Dr. Gilbert chiefly treats his subject from a chemical point of view—the fertilizers best suited for producing a crop, and the composition of the crop after it is grown. The extraordinary dependence of the turnip upon artificial help is shown by many tables, and the erroneous idea that the turnip acts as a *renovator* or restorer of fertility is exposed and disproved. If any crop is capable of completely exhausting a soil of all its available fertility, it is a turnip crop manured with superphosphate of lime. So far from being a renovator it is a waster. Still, circumstances control cases, and the special circumstances which accompany turnip cultivation are of an ameliorating sort. True, if your turnip is sold off the farm it may be looked upon by the landowner as a burglar making off with his goods and chattels, but consumed "on the premises" it yields up its wealth and becomes beneficent. Like John Barleycorn, it springs up again after ever such rough usage, and its spirit lives in succeeding corn crops.

The superiority of swedes over turnips is shown by the much smaller proportion of leaf existing in them in comparison with white turnips; and also in the larger proportion of dry matter in the root. White turnips, especially when dressed with nitrogenous matter, gave 600 parts in weight of leaf to 1000 of root. Swedes gave under similar circumstances 228 parts of leaf to 1000 of root. White turnips were found to contain from 7·66 to 8·54 per cent. of dry matter, while swedes contained from 10·83 to 12·04 per cent. of dry matter. In both swedes and turnips the effect of superphosphate of lime in increasing the crop is remarkable when there is a sufficient stock of nitrogen in the soil. A single crop will, however, deplenish the excess of nitrogen, and fresh applications of superphosphate will not act with the same energy. Take, for example, the series of root-crops grown in rotation with other crops, but recurring at intervals of four years in 1848, 1852, 1856, &c. The portion unmanured yielded 9 tons per acre the first year, but the fifth, ninth, thirteenth, and seventeenth, it only yielded from helf a ton to one ton per per acre. Similarly, superphosphate gave a crop of 14½ tons in 1848, and of 11 tons in 1852; but in 1856, 1860, and 1864, the yields produced by the same top dressing varied from 1½ to 6¾ tons per acre. In no crop more than in the turnip crop is a full supply of nitrogenous and mineral plant foods more essential, and hence the importance of farm-yard manure for its thorough development.

But the most interesting portion of the lecture is the second part, in which the effect of fertilizers upon the proportion of sugar and albuminoids in root-crops is dealt with. The effect of nitrogenous dressings in increasing the power of the plant to take carbon from the air, and especially to elaborate it into sugar, is much enforced. It is, however, evident that the effect of the nitrogenous manure, especially in the case of mangel-wurzel, consists in increasing the crop, and the crop being increased the amount of sugar and dry matter generally, will naturally increase also. So far indeed as percentage goes, it is higher where no nitrogenous manure is used than in any other cases. In fact, wherever nitrogenous manures are employed, the percentage of sugar is

[1] "The Growth of Root-Crops." by J. H. Gilbert, M.A., LL.D., F.R.S., Sibthorpian Professor in the University of Oxford.

mmediately reduced. The great increase in the actual weight of the crop treated with nitrogenous manures, however, completely overrides percentages, and hence the table showing the effect of nitrogenous manures records a great increase of sugar, corresponding with the application of nitrogenous fertilizers. Dr. Gilbert says: "I cannot discuss the physiological explanations of the fact that nitrogenous manures have such a marked effect on the production of the non-nitrogenous substance—sugar."

It would also be an interesting physiological question why the percentage of sugar is highest when no nitrogenous manure is applied, and also why nitrogen, even in the form of farm-yard manure, appears to at once lower the proportion of sugar in mangel. Also, why further additions of nitrogen still further lower the percentage of sugar. The percentages stand as follows:—

Sugar, per cent. (in mangel-wurzel).

No manure	11·4 per cent.
Superphosphate...	10·4 ,,
Farm-yard manure	8·6 ,,
Farm-yard manure and sodium nitrate	7·1 ,,

The actual quantities of sugar per acre stand as follows, in pounds:—

No manure	950 pounds per acre.
Superphosphate	1028 ,, ,,
Farm yard manure	2513 ,, ,,
Farm-yard manure and sodium nitrate...	3109 ,, ,,

Judged by *percentages* we have a descending series, but judged by actual quantities an ascending series of figures. It is somewhat difficult in the face of the diminishing percentages of sugar caused by the application of nitrogenous manures, to see how the functional powers of the plant to make sugar have been heightened or intensified. Still, Dr. Gilbert says: "A direct connection between the supply of nitrogen to the plant and the formation of non-nitrogenous substances is obvious." Might it not be as truly said, "A direct connection between the weight of the crop and the weight of non-nitrogenous substance contained in the crop is obvious"?

We have received a copy of memoranda of the origin, plan, and results of the Rothamsted field and other experiments, which gives an excellent idea as to the work carried on by Sir John Lawes on his Hertfordshire property. Sir John began to experiment on growing crops in 1837, but fixes the actual commencement of the Rothamsted Station in 1843, when he associated Dr. Gilbert with himself in carrying out a magnificent series of agricultural experiments. A large staff of chemists and assistants are employed entirely at Sir John's own cost, and he has provided for the continuance of the work after his death by setting apart £100,000 for the purpose as well as sufficient land for carrying out his intentions. It is pleasant to find Sir John Lawes and his indefatigable coadjutor Dr. J. H. Gilbert still young in mind and constitution, and able to throw all their old ardour into their work.

FLETCHER'S COMPRESSED OXYGEN FURNACE.

THE use of oxygen with coal-gas in a laboratory furnace has up to the present been attended with serious difficulties, owing to the intensely local nature of the heat obtained, and the consequent perforation and destruction of crucibles and other vessels.

In this furnace, diffusion of the heat is secured by using a fine jet of Brin's compressed oxygen directed centrally into one end of a tube a quarter of an inch in bore, open at both ends, the oxygen jet acting as an injector, and drawing with it from four to eight times its bulk of air, the proportion depending on the size of the oxygen jet. This tube, containing the mixture of oxygen and air, is used as the central part of an ordinary blow-pipe of heavy cast-iron, which is placed close up against the burner-opening of one of Fletcher's ordinary injector furnaces, lined with a specially refractory material.

The power of the furnace depends entirely on the quantity of oxygen and gas supplied, and can be adjusted to any power from a dull red, which can be maintained for many hours steadily, without attention, to a heat which will "drop" the most refractory crucible in less than five minutes from the time the gas is lighted.

When working at moderate temperatures, the furnace is sufficiently quiet to admit of its use on a lecture-table, but at its highest power the noise is considerable.

There is no difficulty in adapting the burner to other forms of furnace, provided it is found possible to produce satisfactory casings to withstand the heat; those made for the crucible furnace stand, as a rule, exceedingly well, but with alterations in form great difficulties are introduced, more especially with muffles, which, as at present made, will not stand any sudden

heat, nor will they hold their shape at any temperature approaching whiteness. The burner alone will be useful in heating many substances in the open, but, owing to the broad and diffused flame, it is of little practical value for blow-pipe work.

The special advantages of the apparatus are that it is entirely self-acting, requires no attendance, and that it greatly increases the range of temperatures which can be obtained by any simple apparatus. The largest size at present made takes crucibles not exceeding 3 inches high.

FOREST CONSERVANCY IN CEYLON.

COLONEL CLARKE, the Acting-Conservator of Forests in Ceylon, in his Report for last year says that since attention was called in 1873 to the gradual destruction of forests in Ceylon efforts have been made to check the evil. At first the expense was the great obstacle. The Government did not see its way to expend the large sums that would be necessary before the forests could be regarded as self-supporting. However, in 1885, "The Forest Ordinance" was passed, under which certain areas of forest lands were acquired by the State and made State forests, the owners of those areas or persons having any interest in them being compensated for the loss of their rights. These tracts were to be clearly marked out, and, where necessary, replanted and improved. It is yet too soon to say what the effects will be of this systematic treatment, but the Government hopes that a constant supply of good timber will be at hand, and that the climate of the island will be benefited by increased care of the forests. Forests, Colonel Clarke says, make the climate more equable, increase the relative humidity of the air, and perhaps increase the rainfall. Furthermore, the water-supply is regulated by forests, the springs being more regular and sustained, and the rivers more continuous in their flow. Adjacent fields are protected by them and the speed of the wind is reduced. In tropical countries especially, where, during the wet season, the rain falls in torrents, forests are useful in preventing the soil from being washed away into the rivers and bays. Besides, it is confidently expected that a substantial revenue will be derived from the sale of timber, fuel, &c. India, which, relatively speaking, has not more valuable forests than Ceylon, yielded in the year 1883-84 a gross revenue of £1,052,190, representing a clear profit of £403,815. In the past the native forest-keepers connived with gangs of natives who plundered the forests and deprived the island of the revenue that would otherwise have accrued. The evil effect of the destruction of forests that was so very common until quite recently in every quarter of the globe, is apparent

everywhere. Some striking instances were given in 1885 before the Select Committee of the House of Commons on Forestry. For example, what was fifty years ago the great rice-producing district of the west of India, Ratnagiri, has suffered terribly from the denudation of the Western Ghats of the dense forests which extended all over that range of mountains. Again, the native State of Jinjira was all but ruined by the indiscriminate felling of the forests which covered the whole State, which is from fifteen to a hundred miles in breadth, and about forty in length. Similarly, in Ceylon itself, the chena cultivator in the Southern and North-Western Provinces and in the Province of Uva is threatened with ruin.

The recommendations made by Colonel Clarke in 1887, and approved of by Government were the following:—The Government Agent and the Conservator of Forests were annually, subject to the approval of the Government, to agree on what works were to be accomplished in the way of demarcation, conservation, &c., and these were to be carried out by the Provincial Forester under the authority and protection of the Government Agent. In departmental questions, such as those relating to pay, promotion, discipline, and other matters, the Conservator of Forests was to be supreme. The present mode of working is illustrated by the plan of operations for this year, drawn up by Colonel Clarke, and sanctioned by the Government in March last. The plan is drawn up under four heads: (1) demarcation; (2) timber and firewood supply; (3) re-afforestation; (4) extra establishments. With regard to demarcation it was seen that this was urgently needed in the neighbourhood of the large towns, and Government was, therefore, recommended to allow the whole available staff to be placed at this work. The forests in the northern, eastern, and north-central provinces were to be allowed to take care of themselves for a time, as the population was very sparse in those regions. Thus it was proposed to begin at once with the Mitirigala and Kananpella forests, which lie in the vicinity of Colombo and on the banks of the Kelani. The present system, by which contractors cut timber for the Public Works Department, is to be changed, for no sufficient check can be exercised over the contractors and their workmen, and it is intended to establish depots in various centres where it is considered that there will be sufficient demand for timber and firewood. When this is done, not only will the heavier timber be utilized as at present, but also the lighter portions which are now left to rot in the forests. Two great depots are to be established, one on the east coast and one at Colombo. To the latter will be sent all the timber that is intended for export, such as ebony, satinwood, &c., and to the other depot those timbers which are in demand in India, but which would not bear the cost of transit to Colombo. According to the Report ten depots in all will be established this year. An effort will be made to give the forests of Ceylon a trial for railway sleepers. Colonel Clarke says that the local demand should be met, as two trees which are very plentiful in the island are, in his opinion, suitable for that purpose, Palai (*Mimusops Indica*) and Kumbuk (*Terminalia glabra*). Re-afforestation, in Colonel Clarke's opinion, is not a pressing question; demarcation should first be completed. Many of the Ceylon forests, he thinks, are overworked, and require a long period of rest. To carry out the works now absolutely necessary for the protection of the forests, the staff is to be increased by adding forest-rangers and river-guards.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The list of lectures in Physics this term includes Prof. Stokes's on Physical Optics, Prof. Thomson's on the Properties of Matter and on Mathematics for Students of Physics, and Mr. Wilberforce's on Dynamo-electric Machines. Among the numerous chemical lectures we do not note any very novel feature. Prof. Newton will lecture on the Evolution of the Animal Kingdom, and Mr. Gadow on the Morphology of the Ichthyopsida, recent and extinct. In Botany, the Readership has not yet been filled up; Mr. Gardiner is giving a general elementary course, Mr. Potter is lecturing on the Geographical Distribution of Plants, and Mr. Vaizey on the Classification of Plants. In Geology, Mr. Marr lectures on the Principles and on Advanced Stratigraphy, Mr. Harker on Petrology, Mr. Roberts on Advanced Palæontology, and Mr. Seward on Palæobotany. The physiological and anatomical courses are much as usual. There are three (graduated) sets of demonstration classes in Mechanism, and lectures by Prof. Stuart and Mr. Lyon. In Mathematics, Prof. Cayley is lecturing on Elliptic Functions, Prof. Darwin on Orbits and Perturbations of Planets, Mr. Pendlebury on the Theory of Numbers, Mr. Hobson on Fourier's Series and on Conduction of Heat, Mr. Larmor on Electrostatics, Mr. Forsyth on Theory of Functions, Dr. Besant on Analysis, Dr. Glaisher on Elliptic Functions, and Mr. Herman on Hydrodynamics.

At Sidney Sussex College, an examination for Open Scholarships in Natural Science will be held on January 1 next; two are offered, one of £70 and one of £40; subjects—Chemistry, Physics, Biology, and Geology. The Tutor will give further particulars on application.

King's College offers one Exhibition for Natural Science; examination to begin about December 10.

Emmanuel, Jesus, and Christ's Colleges will hold joint examinations for Open Scholarships on December 11 and following days. All candidates must show a competent knowledge of Chemistry. Candidates may also be examined in Physics, in Elementary Biology, and in Geology. The Tutors will give full particulars.

SCIENTIFIC SERIALS.

Bulletin de la Société de Naturalistes de Moscou, 1888, No. 2. —On the development of Amphipods, by Dr. Sophie Pereyaslavtseva.—List of plants of Tambof, by Litvinoff.—On the great comet of 1887, by Th. Bredichin (in French).—Short notes on some Russian species of *Blaps*, by E. Ballion (in German). —On the Mollusks of Caucasia, by O. Retowski. Twenty-nine species from Novorossiisk, and ten from Abhasia are described (in German).—The *Chlorophyceæ* of the neighbourhood of Kharkoff, by D. B. Ryabinin. Until now, this subdivision of Algæ has been rather neglected in Russia, and only 100 species have been described in the neighbourhood of Moscow. M. Ryabinin's list comprises 233 species, belonging to 74 different genera (with notes in French). — Materials for the flora of Moscow, by Prof. Gorojankin (in Russian). The capital work of the late Prof. Kaufmann, "The Flora of Moscow," which was published in 1866, has been revised by M. Petunnikoff, who compared it with the rich materials of the Moscow Botanical Garden, and published a supplementary list. Students of the Moscow University having been directed during the last three years to collect new materials during special excursions, Prof. Gorojankin has availed himself of all their collections, as well as of a dozen other collections, and now publishes a new supplementary list, which contains 102 new species of Phanerogams and two species of Cryptogams.—The spiders and other insects of Sarepta, by A. Becker (in German).—The Dariinsk mineral water in the Government of Moscow, by A. Sabanéeff (in Russian). The spring is rich in iron, and is like that of Lipetsk.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 3.—Dr. D. Sharp, President, in the chair.—Mr. F. P. Pascoe exhibited a number of new species of *Longicornia*, from Sumatra, Madagascar, and South Africa.—Dr. P. B. Mason exhibited, for Mr. Harris, a specimen of *Chærocampa Nerii*, recently captured at Burton-on-Trent.—Mr. S. Stevens exhibited a specimen of *Vanessa Antiopa*, which he caught in the Isle of Wight in August last.—Mr. E. B. Poulton exhibited a living larva of *Smerinthus ocellatus* in the last stage, fourteen larvæ of *Boarmia roboraria*, and some cocoons of *Rumia cratægata*. The object of the exhibition was to show the influence of special food-plants and surroundings on the colours of the larvæ and cocoons.—Mr. M. Jacoby exhibited a varied series of *Titubœa sanguinipennis*, Lac., from Central America. He stated that many of the varieties exhibited had been described in error as distinct species.—Mr. Billups exhibited specimens of *Bracon brevicornis*, Wesm., bred from larvæ of *Ephestia Kühniella*. He remarked that this rare species had only been recorded as bred on two or three occasions, viz. by the Rev. T. A. Marshall, Mr. W. F. Kirby, Herr Brischke, and Mr. Sydney Webb.—Mr. W. Warren exhibited specimens of *Antithesia ustulana* and *A. fuligana*; also bred series of the

following species: *Eupœcilia Degreyana*, *Stigmonota pallifrontana*, *Cacœcia decretana*, and *Gelechia peliella*.—Lord Walsingham, F.R.S., exhibited specimens of several species of the genus *Cryptophasa* of the Tineina, some of the most remarkable being males and females of *Zitua balteata*, Walker, bred by Mr. Sidney Olliff from pupæ found in January last, at Newcastle, New South Wales, in burrows in branches of a species of Acacia.—Mr. F. D. Godman, F.R.S., exhibited a larva of a *Cicada*, from Mexico, having a fungoid growth on the head.—Captain Elwes exhibited a large number of butterflies, representing about 180 species, recently collected by himself and Mr. Godman in California and Yellowstone Park. The collection included many species of great interest, amongst others a *Cœnonympha* described by Edwards as an *Erebia*, a very rare species of *Thecla*, and a remarkable series of species of the genus *Colias*.—Mr. H. Goss exhibited, for Mr. W. J. Cross, an extraordinary variety of *Agrotis segetum*, caught by the latter near Ely in July last.—Mr. W. L. Distant read a paper entitled "An enumeration of the *Rhynchota* received from Baron von Müller, F.R.S., and collected by Mr. Sayer in New Guinea during Mr. Cuthbertson's expedition."—Mr. Poulton read a paper entitled "Notes in 1887 upon Lepidopterous larvæ, including a complete account of the life-history of *Sphinx convolvuli* and *Aglia tau*"; and Mr. White exhibited specimens of preserved larvæ of *S. convolvuli*, *A. tau*, and other species referred to in Mr. Poulton's paper. Mr. Jenner Weir, Mr. Kirby, Mr. White, and Dr. Sharp took part in the discussion which ensued.

PARIS.

Academy of Sciences, October 8.—M. Des Cloizeaux in the chair.—Order of appearance of the first vessels in the leaves of *Humulus Lupulus* and *japonicus*, by M. A. Trécul. These researches show that, as already announced by the author so far back as 1853, the stipuli may sprout long before any of the leaf-lobes make their appearance. The verification of the phenomenon is easy either in the *Humulus* here studied or in the *Cannabis sativa* previously described.—On the molecular weight and on the valency of perseite, by M. Maquenne. In a recent communication (*Comptes rendus*, cvi. p. 1235) the author showed that perseite possesses the function of a polyvalent alcohol, and that its ethers present the same centesimal composition as those of mannite and dulcite. It was also shown that the analysis of perseite yields the same results as mannite, and that these bodies at equal weight equally lower the freezing-point of their solvents. Hence perseite might be supposed isomerous with the mannites, $C_6H_{14}O_6$. But further researches, and the study of some new derivatives of perseite, clearly show the inaccuracy of the formula of this substance as determined in the former note, and as previously accepted by MM. Müntz and Marcano. It is now shown to be the immediate superior homologue to ordinary mannite with corrected formula $C_7H_{16}O_7$. It is at once the first heptavalent alcohol and the first sugar in C_7 that has yet been determined.—On the orbit of Winnecke's periodical comet, and on a new determination of the mass of Jupiter, by M. E. de Haertl. The results are given of the author's protracted observations, undertaken for the purpose of ascertaining whether any change due to a resisting medium has taken place in the revolutions of this short-period comet, whose return was carefully recorded in 1858, 1869, 1875, and 1886. A fresh calculation is made of Jupiter's mass, based on its disturbing effect on the comet's orbit. The value of the mass that best satisfies all the observations is $m = 1 : 1047{\cdot}1752 \pm 0{\cdot}0136$.—Reflected image of the sun on the marine horizon, by M. Riccò. The observations here recorded have been taken since 1886, on the east terrace of the Observatory of Palermo, 2 kilometres from the shore and 72 metres above sea-level. They were interrupted this year by the foggy horizons, probably caused by the eruptions of Vulcano, which began on August 2, and have continued at intervals down to the present time. The observations will be renewed next spring, with the return of the sun to the marine horizon. Under clear skies and in calm weather the elliptical form of the image of the sun is very evident, so that it seems strange the ancient astronomers did not perceive in this phenomenon an indication of the rotundity of the globe.—A study of the heats of combustion of some acids connected with the series of the oxalic and lactic acids, by M. Louguinine. The results of the researches communicated in this memoir have reference to the malonic, succinic, pyrotartaric, suberic, sebacylic, and oxyisobutyric acids. The first five present homologous relations between themselves and with oxalic acid; the last is similarly connected with lactic acid.—On the freezing-points of the solutions of the organic compounds of aluminium, by MM. E. Louise and L. Roux. The determination of the vapour densities of these substances has led the authors to give them the general formula Al_2X_6. Their further investigations, here described, have been carried out with a view to determining the value of the molecular weights of the organic compounds of aluminium by Raoult's method based on the lowering of the freezing-points of the solutions. Their new determinations confirm their previous conclusions on the vapour densities, and show that these substances can in no case be represented by the simple formula AlX_3.—M. E. Picard contributes a paper on Laplace's transformation and linear equations with partial derivatives; and the Perpetual Secretary gives the analysis of a note presented by M. G. Govi on a new method for constructing and calculating the place, position, and size of images given by complex optical systems.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Elementary Commercial Geography: H. R. Mill (Cambridge University Press).—Star Atlas: Dr. H. J. Klein, translated by E. McClure (S.P.C.K.).—Reports on the Mining Industries of New Zealand (Wellington, N.Z.).—The Illustrated Optical Manual, 4th edition: Sir T. Longmore (Longmans).—British Birds, August, September, and October: H. Saunders (Gurney and Jackson).—British Dogs, No. 24: H. Dalziel (U. Gill).—The Speaking Parrots, Part 6: Dr. K. Russ (U. Gill).—Elementary Statics: Rev. J. B. Lock (Macmillan).—Chemical Notes and Equations, 3rd edition: R. M. Murray (Maclachlan and Stewart, Edinburgh).—Catalogue of the Fishes in the Collection of the Australian Museum, Part 1; Recent Palœichthyan Fishes: J. D. Ogilby (Sydney).—Three Formations of the Middle Atlantic Slope: J. M. McGree.—Zeitschrift für Wissenschaftliche Zoologie, xlvii. Band, 2 Heft (Williams and Norgate).—Bulletin de l'Académie Royale des Sciences de Belgique, No. 8 (Bruxelles).

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